NASA CONTRACTOR REPORT

NASA CR-1222

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SPACE TECHNOLOGY TRANSFER AND DEVELOPING NATIONS

by Peter E. Glaser, Robert M. Jolkovski, Claudio Marguéron, and Walter M. Noel

Prepared by

ARTHUR D. LITTLE, INC.

Cambridge, Mass.

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • OCTOBER 1968

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

For sale by the Clearinghouse for Federal Scientific and Technical Information
Springfield, Virginia 22151 – CFSTI price $3.00

ACKNOWLEDGMENTS

The authors gratefully acknowledge the valuable contributions, discussions, and support of Mr. R. Barnes, Mr. A. Frutkin, Mr. R. Griffin, Mr. G. Howick, and Dr. R. Lesher of NASA in carrying out this study. We thank Dr. A. Kent and Mrs. E. Hartner of KASC, and Mr. P. Wright of NERAC for their cooperation. We also express our appreciation for the valuable information given to us by many U. S. companies with interests or operations in Brazil, AID, the Library of Congress, our professional associates in industry, universities and government, and our colleagues at ADL.

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TABLE OF CONTENTS

ACKNOWLEDGMENTS		iii
I.	SUMMARY	1
	A. Purpose and Scope	1
	B. Conclusions	1
II.	INTRODUCTION	4
	A. Background	4
	B. Method of Work	5
III.	THE SEARCH AND MATCHING PROCESS	7
	A. The NASA Scientific and Technical Information System	7
	B. The Role of Computerized Information Sources	9
	C. Identification of Relevant Technology	10
	D. Selection of Search Topics	11
	E. Experiments with the Matching Process	17
	F. The Matching Process	19
	G. Processing of Search Topics	21
IV.	RESULTS OF MATCHING NEEDS AND TECHNOLOGY	25
	A. Information System Outputs	25
	B. Types of Matches Obtained	25
	C. Selected Matches	28
	D. Observations on Matching Technology with Needs	72
V.	THE ROLE OF TECHNOLOGY TRANSFER IN ECONOMIC DEVELOPMENT	74
	A. Characteristics of the Technology Transfer Process	74
	B. Economic Considerations	76
	C. Implementing Technology Transfer	76
	D. Advanced Technology	85
VI.	MECHANISMS FOR TRANSFER OF SPACE-GENERATED TECHNOLOGY	87
	A. Direct Problem Solving	87
	B. Dissemination of Information	88
	C. The Package Technology Concept	89
	D. Application of Large Systems on a Global Scale	95
APPENDIX A	BRAZIL AND HER TECHNOLOGICAL NEEDS	98
	Agriculture	100
	Public Health	102

	Exploration and Utilization of Natural Resources	104
	Industrialization	107
	Housing	110
	Education and Training	111
	Telecommunications	113
	Transportation	115
APPENDIX B	INTERVIEWS AND MEETINGS TO DEVELOP SEARCH IDEAS	122
APPENDIX C	ADVANCED FOOD PROCESSING PLANT (PACKAGE OF TECHNOLOGY)	124
APPENDIX D	EXPERIMENTAL MODEL CLINIC (PACKAGE OF TECHNOLOGY)	128
APPENDIX E	ADVANCED TECHNOLOGY EDUCATION SYSTEMS	139
	Brazilian Programs	139
	Slow-Scan Television	140
	High-Contrast Television	142
	U.S. Companies Views	142
	Relevant Search Results	145
APPENDIX F	EARTH-RESOURCE SURVEYS	146
	Future Applications	146
	Brazil - U.S. Cooperative Program	147
	Potential Applications to Argriculture	148
REFERENCES		151
GLOSSARY		153

I. SUMMARY

A. PURPOSE AND SCOPE

This report describes a pilot study program performed by Arthur D. Little, Inc. (ADL), on behalf of the National Aeronautics and Space Administration (NASA), under NASA Contract NASw-1649, to determine the prospect of applying space-developed technology to the technology needs of developing nations.

In order to carry out this study, we tested the feasibility of using space-generated technology to meet the technology needs of Brazil. (Brazil was selected by NASA as an example of a developing nation.) We examined Brazilian industry, government, and social structure to identify these needs, and, using the resources of the NASA Scientific and Technical Information System, we assessed the availability of advanced technology. We then sought to match the Brazilian economy's needs and the documented technology in the NASA information system. Finally, we considered alternative potential mechanisms for transfer of advanced technology to Brazil.

B. CONCLUSIONS

Having identified more than 40 plausible matches of need with technology, we conclude that space-generated technology is relevant to the needs of developing nations. However, the successful application of this technology depends not only on its identification and availability, but also on the existence of viable transfer mechanisms. More specifically, we found that:

1) Using the access provided by NASA-sponsored regional dissemination centers, many reports, articles and other documentation in the NASA system were identified which contained technology relevant to problems of developing nations in such fields as agriculture, health, natural resources, industrialization, housing, education and training, communications and transportation.
2) For advanced technology information systems to play an optimum role in the transfer process to developing nations, adaptations are required in methods of searching, information content, availability of search output and arrangements to facilitate

contact between information specialists, technologists, and the potential users of the advanced technology.

3) Matching technology with a need is necessary but usually not sufficient to cause transfer; even where specific plausible matches can be identified, they represent only a starting point for actions leading to application. At every stage of the transfer process, barriers to change exist which impede and in many cases prevent implementation.

4) Although conventional and advanced technology has been transferred to developing nations using a variety of mechanisms, there is no single proven "best way" of doing it. Methods for technology transfer should be adapted to special conditions in each country and draw on all the resources available -- not only in the fields of technology, but also in the management and social sciences.

5) Four potential transfer mechanisms for advanced technology were identified during the study:

   . Direct technical problem solving (pp. 87-88),
   . Dissemination of information on specific innovations (pp. 88-89),
   . Packaging of advanced technology into operating models for demonstration purposes (pp. 89-95),
   . Participation by developing nations in global space efforts such as weather and communications satellite systems (pp. 95-97).

   All four mechanisms have their advantages and limitations in terms of cost, potential impact, likelihood of success, and appropriate or inappropriate use. They are, of course, not mutually exclusive.

6) Effective technology transfer programs require significant commitments in both the disseminating and the recipient nations:

   (a) Willingness in the disseminating nation to make advanced technology available and to commit the resources to the adaptation of information systems (see #2 above) and to such necessary supplementary activities as the orientation of information specialists and transfer agents from the recipient nation,

(b) Commitment in the recipient nation of the tangible resources -- people and money -- to specific transfer projects, plus the willingness to accept the consequences of change.

The next steps in testing the actual transferability of technology/need matches such as those identified in this study could involve:

1) Established national and international aid agencies and foundations,
2) Government departments and private industry in Brazil and other developing countries,
3) Private industry in the United States with related industrial activities abroad, and
4) Government agencies, private industry, profit and nonprofit institutions which may have a general interest in the matches with technology needs identified in this study.

II. INTRODUCTION

A. BACKGROUND

The economic development of developing nations is often impeded by a circular chain of cause and effect. This plight has been expressed effectively in the following quotation: (McClelland, 1961)

> Nowhere does such a conclusion ['the simultaneous irrational efforts of many people that ultimately justified the enterprise of some of them,' Sawyer, 1954] force itself on one's attention more vividly than in the consideration of the current plight of underdeveloped countries. In terms of traditional economic analysis, it is hard to see how they can ever advance at all. The risks are too great for the entrepreneur, since there is no apparent demand for his products. The labor force is not trained in the skills needed for a machine world. Inventions are lacking which fit peculiar local conditions, and those from the West cannot be utilized because of lack of capital to buy them or the human or other resources necessary to use them once bought. Moreover, population is increasing faster than productivity. To an economist used to thinking in exclusively rational terms, the case indeed looks pretty hopeless; no reasonable man would invest in an underdeveloped country.

The transfer of advanced technology as a relevant and applicable resource for developing countries appears to provide new opportunities. The task seems simple enough at first, but the formidable obstacles of illiteracy, ancient cultures, and often completely virgin resources make direct transfer of scientific and technological knowledge from the United States to a developing country complex.

The utilization of new knowledge gained through space research has long been a concern of NASA. Since 1962, through the Technology Utilization Program, NASA has been making available to industry the benefits of more than a decade of research and experimentation associated with astronautics, aeronautics, and a multitude of supporting technologies related to the national space program.

B. METHOD OF WORK

In carrying out our investigations, we have had to immerse ourselves in a socio-economic study of Brazil to understand technological needs, to develop methods that will effectively utilize the information systems developed by NASA, and to find the best ways to match space-generated technology with Brazil's technological needs. As a result of our previous studies for NASA and others, we were aware that the subject of technology transfer and technological development had recently received widespread attention from individuals, institutions (academic, industrial, and government), intergovernmental agencies, and the United Nations. We benefited from the concepts and insights of many authors on the process of meeting the technological needs of developing nations, in addition to the experience gained from our own involvement in the economic development of emerging nations.

We used the resources available through NASA and the U.S. Agency for International Development (AID); we also consulted directly with AID personnel in this country, individuals both in universities and industries who are familiar with the various aspects of technology transfer, and representatives of companies who have direct business ties with Brazil. We made no direct contacts in Brazil, although a number of contributors to this program either had worked in Brazil or were Brazilians working in the United States.

This study could not have been carried out without the full cooperation of the Regional Dissemination Centers (RDC's) sponsored by the NASA Technology Utilization Program -- particularly the Knowledge Availability Systems Center at the University of Pittsburgh and the New England Research Applications Center at the University of Connecticut -- and the NASA Scientific and Technical Information Facility, College Park, Maryland. The output of the information systems operated by these centers was obtained through a variety of search strategies and methods designed to cope with the large quantity of available information.

We performed the following tasks to accomplish the purpose of the program:

1) Compiled a specific list of Brazilian needs for technology,
2) Evaluated technology needs in light of political, economic, and social factors,

3) Worked with specified Regional Dissemination Centers to search for space-generated technology of possible relevance to the needs identified,
4) Matched needs with documented technology in the NASA information system,
5) Examined various methods for achieving transfer and identified mechanisms which appear to have the highest potential for use in Brazil and in less developed nations in general.

The methods we used in our work were pragmatic and experimental. We emphasized best results rather than rigorous adherence to procedures. We used informal, but informed, judgment from a large team of contributors, including industrial and aerospace technology specialists, information scientists, Brazilian experts, industrialists with knowledge of Brazil, development economists, and social scientists. The specific tasks performed were not accomplished in isolation, but in interaction with the other tasks, with continual reexamination of results and methods and their contribution to the overall goal.

III. THE SEARCH AND MATCHING PROCESS

A. THE NASA SCIENTIFIC AND TECHNICAL INFORMATION SYSTEM

In the Space Act of 1958, the Congress of the United States specifically charged NASA with the obligation to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." To carry out portions of that obligation, the Scientific and Technical Information Division was established to scan, screen, and store the best possible accumulations of the world literature in the field of aerospace technology.

Documents now in the NASA information system total more than half a million separate items. Of these, 200,000 predate 1962 and are under conventional library controls. The more recent portions of the collection - 210,000 reports and 100,000 entries from journals, books, and proceedings - are in computer storage at NASA's Scientific and Technical Information Facility in College Park, Maryland. The collection is currently growing at the rate of 70,000 documents per year. These documents, which are accepted only after very careful screening, are added to the NASA collection from many sources, both in the United States and abroad. The post-1962 collection, for example, includes 65,000 items of NASA and NASA-contractor origin, 175,000 items of other domestic aerospace activities from industries and universities, and 80,000 foreign acquisitions. In this last category, close to 10,000 items a year are being acquired through more than 290 NASA foreign document exchange arrangements in effect with 42 countries. Many of the foreign documents have been translated into English.

Foreign and domestic books, journals, and proceedings are scanned by the American Institute of Aeronautics and Astronautics and are announced in International Aerospace Abstracts, which indexes only published literature. The world's report literature in this field is similarly announced in Scientific and Technical Aerospace Report.

Documents from this information system are available on microfiche.

Each microfiche holds 60 page images, which can be magnified for reading through a viewer or for full-size reproduction. Each microfiche itself can be reproduced as a unit, repeatedly if desired, to provide a complete library of aerospace technical information wherever microfiche are stored.

While the program of the NASA Scientific and Technical Information Division is designed to serve the aerospace technical community (NASA in-house users, NASA contractors, and other government agency aerospace programs), the NASA Technology Utilization Division was established in 1962 to foster the use of NASA-generated technology outside the aerospace sector. The close connection and the complementary nature of the two programs is illustrated by the organizational placement of these divisions within NASA as the two operating arms of the Office of Technology Utilization.

For the non-aerospace user, one of the principal points of access to the NASA information collection is through the NASA-sponsored Regional Dissemination Centers (RDC's). At the time of this study, eight such centers were providing service to fee-paying subscribers: (1) Aerospace Research Applications Center (ARAC) of Indiana University, Bloomington, Indiana; (2) Center for Application of Science and Technology (CAST) of Wayne State University, Detroit, Michigan; (3) Knowledge Availability Systems Center (KASC) of the University of Pittsburgh; (4) New England Research Applications Center (NERAC) of the University of Connecticut, Storrs, Connecticut; (5) North Carolina Science and Technology Research Center (NCSTRC) of the North Carolina Board of Science and Technology, Research Triangle Park, North Carolina; (6) Project ASTRA of the Midwest Research Institute, Kansas City, Missouri; (7) Technology Application Center (TAC) of the University of New Mexico, Albuquerque, New Mexico; and (8) Western Research Application Center (WESRAC) of the University of Southern California, Los Angeles, California. In this study, we worked with KASC at the University of Pittsburgh and NERAC at the University of Connecticut.

Though each RDC is different in many respects, all have the following elements in common:

- The objectives of becoming self-supporting through fees paid for services rendered,

- An orientation toward fulfilling the service role of their institutions, as well as their research and teaching roles, and
- Direct access to the NASA information system through copies of the NASA bibliographic control computer tape (updated monthly), plus a set of the NASA microfiche collection.

Information specialists at the Centers design search strategies to obtain the most effective access to the information bank for retrieving relevant information under a specific search topic. The Centers also have subject specialists who can translate a problem statement (e.g., "Is aerospace technology applicable to the development of reliable, low-cost water meters?") into computer solution language with a special vocabulary of words and terms applicable to aerospace technology; these specialists can also provide abstracts of documents to show the extent to which the information is applicable.

B. THE ROLE OF COMPUTERIZED INFORMATION SOURCES

Normally, a portion of the technology which is to be transferred can be found in documents. NASA's development of methods for managing very large collections of reports permits the document collection to be one resource upon which the technology transfer process can draw. Documents do not, of course, constitute technology, and the subject matter of reports is not the only thing eligible to be transferred; nevertheless, such information can be very valuable when properly placed in the hands of those who can use it. This is why the large information systems now in existence are an important resource.

However, present information systems are operated largely for those who are either engaged in technology production or are looking for new products in a technologically advanced society. In the future, the systems might be adapted for technology transfer to a developing nation, but methods for doing this are still evolving. One clear need is for people who can translate nontechnical needs into the indexing language of the information system.

Currently, the indexing language is heavily oriented to technical terminology. The system is not set up for people who can not routinely think of relevant technology when faced with a nontechnical need, such as reducing

the menace of piranhas in Brazil's rivers. It would be far better if the information system would supply suggestions: "Work on shark-repellants is reported in the collection. Is this of interest?"

No doubt the future holds even greater promise for the computer as a direct aid in technology transfer. Advanced techniques for the analysis of large files are known and have proved useful, and the use of computers to assist in retrieval and technology transfer is being explored. For example, identification of relevant technology can be aided through a process of systematic association. In this process the vocabulary of technical terminology developed by the subject specialists is posed as a query to a computerized associative system (Jones, 1968). The latter system expands the terminology into a much larger set of related terms and provides a printout for review by the subject specialist. This computer-prepared list can suggest good search terms to identify relevant technology, even if the subject specialist made a poor initial choice of terms from the NASA Subject Authority List.

Of course, computerized information by itself can be only a useful adjunct to technology transfer. An essential part of the process is the disseminator, who refines what is available for transfer, provides the means for transfer, and assists in implementation.

C. IDENTIFICATION OF RELEVANT TECHNOLOGY

The identification of relevant technology is a process requiring technically trained specialists who are familiar with the economy of a developing country. Confronted with a range of possibly relevant technology, these specialists establish the sectors of the economy in which disseminators and recipients could be motivated to act. Ideally, the recipients should be able to define their needs. In our study, however, the concept of the needs and how to meet them had to be supplied by the specialists familiar with Brazil and technologists thoroughly conversant with NASA technology and the contents of the scientific and technical information collection.

The steps by which the technologists identified relevant technology were briefly as follows:

1) They were first briefed by a development economist on broad features of the Brazilian economy, with emphasis

on the potential role of technology in various sectors of that economy.

2) They familiarized themselves with the economy through reading and discussion with individuals who had first-hand experience in Brazil; from this they tentatively established the new technology which could potentially be applicable.

3) They then discussed the relevant technology with economists familiar with Brazil and jointly evolved a list of tentative areas for detailed study.

4) Finally, they discussed potentially relevant technology with information specialists, who started to elicit clues for possible solutions to the problem. These first clues must be expressed as technical terms in the NASA Subject Authority List.* The ADL information specialist has at his disposal an Association List (Jones, 1968), which provides suggested topics, and a NASA Subject Authority List to predict whether the information system would be able to provide documents relevant to the problem.

D. SELECTION OF SEARCH TOPICS

After surveying Brazil's many technological needs, which are reviewed in Appendix A, we selected several for further study. These are not necessarily the most important of her needs; they are merely samples that we chose in order to examine the feasibility of applying space-generated technology to such needs.

*Superseded by the NASA Thesaurus, SP-7030, Dec. 1967.

Brazilian technological needs fall in the following general categories:

- Agriculture,
- Public health,
- Exploration and utilization of natural resources,
- Industrialization,
- Housing,
- Education and training,
- Communications,
- Transportation.

Within these general categories, we selected specific needs whose fulfillment might help to advance Brazil's economy. To obtain a good basis for this selection, we talked with individuals at various American companies having interests in Brazil (see Appendix B), officials in U. S. Government agencies, and ADL development economists familiar with Brazilian needs.

To identify pertinent technology, we considered two types of "search topics" -- i.e., concepts presented in the form of a Brazilian need or problem. One type was based on specific needs; these need-based search topics ranged from the very specific (such as hand tools) to those that would require an integrated system for successful development (such as visual aids). The other type was technology-based, for which we used our knowledge of aerospace technology to select developments (e.g., astronaut foods) that we intuitively believed would fit some needs without attempting to predict what such needs would be.

Of the need-based search topics that we selected, some were specific to a given locality, a particular industry, or a single company. Others were more broadly defined, both in terms of their occurring in large segments of Brazilian society and in terms of the kinds of technological resources which might be expected to contribute to their solution. Some were selected as examples of social, human, or environmental problems; others were related to industrial products or processes.

We established a list of search topics without knowing whether any matches could be found or how relevant such matches would be. This list, which is reproduced below, was a first attempt to express search topics in

a language that could be translated into a solution and made accessible to the information specialist for entry into the NASA information system.

NEED-BASED SEARCH TOPICS

Topic Agriculture	Description
Cottonseed	Removal of gossypal to upgrade for human and/or animal consumption
Cattle	Low-cost fencing Breeding to develop strains suitable for environments in Brazil
Coffee	Breeding to develop strains that will ripen at the same time
Brazil nuts	Control-eradication of aflatoxin fungus
Carnauba wax	Mechanical harvesting - beating, scraping, etc.
Castor beans	Mechanical harvesting Upgrading castor bean residue for animal consumption
Soybeans	Breeding to develop new strains with appropriate photosensitivity for equatorial environment
Fish	Fish-detecting devices to search ocean bottom for shellfish, lobsters, etc. Improved boats Improved nets, etc.
Forest clearing	Improved techniques to eliminate need for burning, which destroys timber, causes leaching of soil, etc.
Maintenance of pasture land	Chemicals or other methods to inhibit jungle growth when pasture land is not used for a year or two (carbon disulfide, now used, is too expensive and dangerous)

Topic	Description
Agriculture	
Water	Catchment, water wells, pumps, pipe lines, ditch digging
Public Health	
Drugs against tropical diseases	Production, packaging, shipment
Nutritional additives (protein, etc.)	Upgrade food staples, distribution system
Antibiotics from Brazilian raw materials	Control endemic diseases
Anti-epidemic vaccines	Control effect on worker productivity
Automated diagnostic techniques	Systems to minimize dependence on highly skilled diagnosticians
Schistosomiasis	Control or elimination
Hoof and mouth disease	Control or eradication
Piranhas	Control or elimination
Hospital equipment	To aid in treatment, automation, reduce skilled labor requirements
Sanitation	Waste collection and disposal
Exploration and Utilization of Natural Resources	
Iron pyrites	Recovery of sulfur, iron, and carbon from by-product of coal mining (Santa Catarina fields)
Timber resources	New types of paper
Oil shale	Lower cost extraction
Fuels from petroleum residues	Brazil has surplus of heavy fractions
Road construction	Low-cost techniques for low-volume roads in flat areas
Hydroelectric power	Transmission and distribution

Topic	Description
Industrialization	
Petrochemicals	Polymer derivation
	More complex, higher value products (urea and nitrogen derivatives)
Sugar	Industrial and other non-food uses
Coffee	Industrial and other non-food uses
Tires	Efficient manufacturing for odd sizes in short runs
Coir fiber	As mattress material
Knitting	Latest technology
Industrial residues	For animal feeds
Packaging	Cost reduction for low-volume production and filling of paper, plastics, cans, bottles, etc.
	For coffee beans and raw sugar
Upgrading exports	New technology to make additional processing of Brazilian raw materials economically feasible
Hand tools	Because of cheap labor in Brazil, improved low-cost hand tools may reduce costs more than expensive machinery in many manufacturing operations
Housing	
Paints	Insect resistance, temperature control
Thermal insulation	Housing, food preservation, clothing
Plastic honeycomb	Structural materials
Coatings	Window sun reflectors

Topic	Description
Education and Training	
Books	Low cost in low-volume production
Visual aids	Films, new projection techniques, power supply, miniaturization, sensing, communication, data processing
Classroom construction	Cost-saving techniques and materials
Teacher training	Methods for massive programs, adaption to environment, motivation
Information systems	Educational materials correlation, selection, retrieval, indexing, and management
Agricultural extension service	To facilitate and promote the dissemination of information on markets, distribution methods, fertilizer, seeds, other agricultural products/technology
Communications	
Brazilian laws and regulations	Improved information and analysis system
Telegraphic communications	To increase speed of inter-regional monetary transfer
Microwave communications system	Communications between widely separated population centers
Transportation	
Cattle	Transportation to domestic and export markets
Coffee	Reduction of volume for storage
Milk	Preservation without refrigeration by sterilization and sealing, etc.
Fish and other perishables	Means to extend shelf life

Topic	Description
Transportation	
Flowers	Preservation in shipment (ethylene-oxide approach)
Oranges	Improved shipping techniques, artificial atmosphere, etc.
Papaya	Preservation in handling and storage

TECHNOLOGY-BASED SEARCH TOPICS

Nitrogen cooling	For preserving foods in transport and storage
Plastic fiber glass pipe	Large size pipe for water and sanitation systems and irrigation
Packaging	For preservation, to aid distribution, shipment
Astronaut food	Nutrition, food preservation, new foods
Bearings	Reduction of maintenance problems
Batteries	Reliable power supplies for small systems
Solar energy	Power for remote systems
Shop techniques	Manufacturing methods
Rescue equipment	Land and sea location of airplane passengers
Water meters	Reliable and low cost for irrigation systems

E. EXPERIMENTS WITH THE MATCHING PROCESS

Exploratory discussions with KASC gave us an understanding of the operation and capabilities of the NASA information system. Although at first we had little grasp of the contents of that system and the results we could expect, we were ready to begin matching technology resources with Brazilian needs on an experimental basis. Accordingly, we selected three different

methods in approaching the RDC:

1) For a selected search topic (e.g., paint), we evolved a search strategy consisting of index terms obtained from the NASA Subject Authority List and linked by Boolean AND/OR relationships. The search strategy and the search topic were then submitted to the RDC with the request that it be entered into the computerized information system and all abstracts forwarded to us.
2) We submitted the search topics to the RDC and, after consulting the information specialists and subject specialists, requested that they limit the abstracts to a specific number of those they considered most relevant to the needs.
3) We submitted a major subject area (e.g., agriculture) to the RDC that had access to specialists on this subject. After meeting with them and discussing our understanding of the needs in this area, we requested that they develop search topics and search strategies and supply us with the abstracts they considered most relevant. We did not submit all problems at the same time, so as to be able to evaluate the methods used both by us and by the RDC and to permit us to shift the emphasis in the remaining searches that were to be carried out by the RDC.

As we began to receive results (in the form of abstracts of documents) we noted a wide variation of relevance. We also became aware of economic constraints on the matching processes: an exhaustive search of all Brazilian problem topics would be economically out of the question.

The language in which problems were expressed was often not the same as that of the technology offering a solution. We had to bridge this gap. As a first step in some cases, a broad preliminary search of the data would provide clues to guide the way in which the problems should be defined.

For example, the presence of piranhas in Brazilian rivers and streams is a serious economic problem, because these voracious fish destroy livestock.

A search using such terms as "piranha," "control," or "rivers" failed to produce relevant information, because "piranha" is not an indexing term, while thousands of documents are indexed under "control." But the word "shark" (which is indexed) suggested repellents similar to those used by aviators downed in shark-infested waters; a search based on this topic was quick, economical, and to the point.

A different kind of example occurred in medicine. Our Brazilian experts understood the country's public health problems -- poor hygiene; inadequate diet; lack of money, facilities, and doctors; widespread diseases and parasites; the difficulty of obtaining patient cooperation, and so on. Rather than search each problem area, we looked broadly at aerospace medicine (involving several thousand abstracts), trying to identify those technological advances that might conceivably be useful.

A flexible process evolved, in which decisions about how best to proceed depended to a large extent on the particular subject, rather than on general principles. Since a comprehensive search of 250,000 documents was not economically feasible, we had to make quick decisions on very limited information, without being completely arbitrary. We became more concerned with best matches of resources and need than with solutions to a fixed set of problems.

Another type of flexibility we found to be required concerned the frequent change in scale of needs as well as resources. Ideally, one would like to look at both on a very broad scale, to map out broad areas of correspondence before going into details.

F. THE MATCHING PROCESS

With a diverse group of people participating, a common vocabulary of concepts for describing the subject is required. Matches can be more easily identified when the language used by program participants is similar and well understood by the subject specialists involved, and when Brazilian needs are expressed in terms of the technology described in the literature. Thus, to facilitate the matching of information with needs, we developed a working vocabulary and a set of rules and relationships among the various program contributors that would enable the latter to convey and judge new concepts and the usefulness of new technology.

The information system can not explore search topics until they are translated from problem-oriented language into technology-oriented language. The distinction is illustrated below.

- Problem-oriented search topics - e.g., forest clearing, piranhas, road construction, sanitation.
- Technology-oriented search topics - e.g., refrigeration, hydro-electric power, solar cells, water meters.

The results we expected to obtain were of the following kinds:

- "Bullseye" solutions - permit immediate access to the information system as the result of common terminology and knowledge of both the technology and the system capability;
- Adaptive solutions - require both translation of terminology and creative and inventive inputs;
- Directional solutions - need either translations of terms or adaptive steps to point to directions that the RDC can pursue.

After the search topics were selected and defined, ADL and the RDC interacted in the following ways:

ADL Input	RDC Input
Terms from NASA Subject Authority List were produced by manual screening or by systematic association	Search strategy was devised for specific search topics
Statements were prepared to give directional solutions	Subject specialists expanded search to include other terms
Adaptive solutions were identified in a creative work session with the RDC	Interaction with ADL in creative work sessions
Problem description only was supplied (test case)	Used own resources to find solution
Problem was reexamined to seek alternative solutions	Problem was reexamined, or alternate search strategy was devised

The types of participants and their functions were as follows:

- Development economists - Brazilian experts capable of identifying needs,
- Technologists (ADL) - engineers broadly skilled in matching problems with solutions and aware of industrial and space technology,
- Subject specialists - engineers and scientists deeply involved in the methods and problems of a given technical area,
- Information specialists (RDC) - people who know the NASA information system and are acquainted with technology,
- Information specialists (ADL) - people who assist ADL technologists in the interaction with an RDC and are familiar with the methods and problems of information science.

The information flow between ADL and the RDC is shown in Figure 1.

G. PROCESSING OF SEARCH TOPICS

In this study we worked most closely with the Knowledge Availability System Center at the University of Pittsburgh. KASC took the search topics we had identified and supplied abstracts in accordance with the following procedures:

1) When a search topic is received, it is numbered and logged into the records.
2) A subject specialist is assigned. The latter is a member of the engineering staff of the University of Pittsburgh, or a graduate engineer or scientist on the KASC staff. The assignment is based on the reviewer's field of education and experience.
3) Search and transmittal statements are written. A search statement is a complete description of the search topic, together with any additional statements needed. A transmittal statement is a short, identifying statement used on the transmittal form.
4) A Master Question Sheet containing the two statements, the name of the reviewer, and other pertinent information is typed. Copies of the Master Question Sheet go to (a) ADL, (b) the subject specialist, and (c) the information specialist, as well as to records and research. If either ADL or the subject specialist wishes to clarify the search statement or suggest keywords, he can do so at this stage.

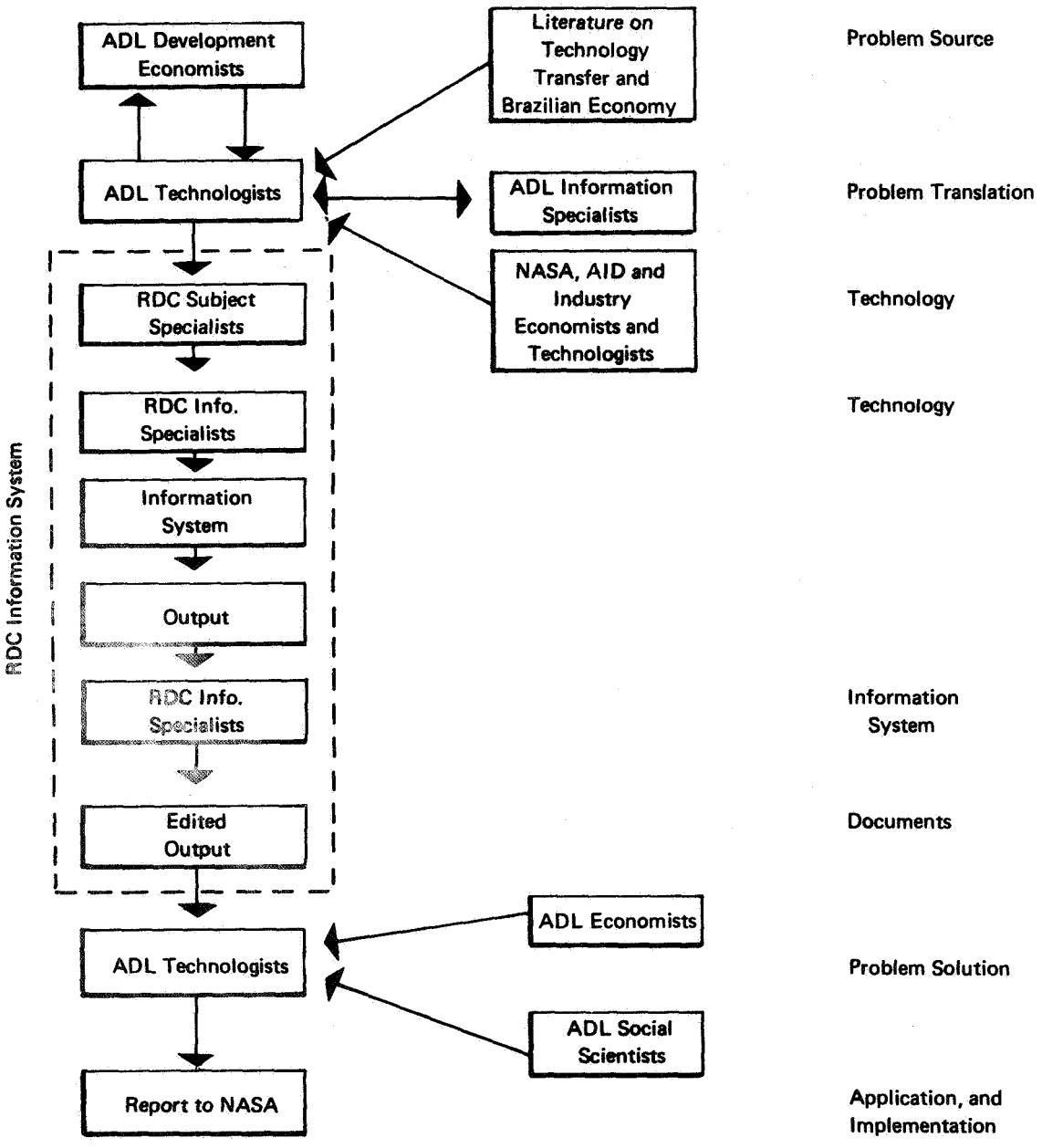

FIGURE 1 INFORMATION FLOW – PILOT STUDY FOR TECHNOLOGY TRANSFER

5) The strategy is prepared by the information specialist familiar with the search-topic technology. The strategy consists of index terms that are obtained from the NASA Subject Authority List and linked by a Boolean AND/OR relationship. The Boolean search prescription is key-punched onto a series of IBM cards; the first card holds the search topic number and other identifying codes, and the other cards (no more than ten in number) carry the Boolean strategy.
6) The index computer tape is then searched. This tape consists of a linear file of document accession numbers and descriptors. The computer search program, by a compare technique, identifies those accession numbers whose descriptors fit the Boolean strategy. The computer print-put contains the search topic number and the accession numbers of the pertinent documents in serial order.
7) After the print-out is completed by the computer, the abstracts listed (by accession number) for each search topic are manually reproduced from abstract cards.
8) The print-out, abstracts, and work folder are given to the subject specialist. He examines the abstracts and removes those whose technical content does not match the search topic.
9) An evaluation sheet listing pertinent abstracts is typed and submitted to ADL with the abstracts.

The abstracts submitted to ADL relevant to a specific search topic provided salient facts about the technology contribution contained in the RDC information system. In our evaluation of these abstracts we did not exclude those of documents which described technology developed outside the NASA programs; rather, we were guided by the relevance of the subject matter contained in the abstract.

By design, several searches resulted in the retrieval of a large number of abstracts. In examining these abstracts, we often identified additional valuable topics that would not have been expected from the search strategy. Even when a large number of abstracts were retrieved for a specific search topic, we preferred to carry out our own selection of the most relevant technology to meet specific needs. The criteria we used to screen abstracts

were as follows:

Importance to Brazil,

Greatest possible impact on Brazilian technological needs,

Likelihood of acceptance,

Utilization of local resources,

Possibilities of adaptation to the Brazilian environment,

Existence of entrepreneurs to implement the technological contribution,

Significance to the Brazilian economy of the technological contribution,

Possibilities of financial success,

Market potential,

Special requirements and obstacles for acceptance and implementation.

We used an alternate approach in working with the New England Research Application Center. We supplied NERAC with the search topics in the areas of agriculture and public health and suggested that it evolve, in conjunction with the College of Agriculture of the University of Connecticut, search strategies for individual topics it was most interested in and submit its selections of relevant technology to us.

IV. RESULTS OF MATCHING NEEDS AND TECHNOLOGY

A. INFORMATION SYSTEM OUTPUTS

Using the search topics presented in Chapter III as a starting point, we obtained abstracts describing the documents with the NASA information system. We were then in a position to seek matches to Brazilian technology needs. Table 1 indicates the number of abstracts we obtained from KASC. Additional literature searches (duplicating those carried out by KASC) were performed by the NASA Scientific and Technical Information Facility on water meters, nutritional additives, and road construction methods and materials.

NERAC carried out computer searches on advanced knitting technology and manufacture of inexpensive mattresses. It also undertook a separate evaluation of technology needs in agriculture (NERAC, 1968).

As soon as appropriate abstracts were identified, substantiating documents were ordered through the NASA Scientific and Technical Information Division, Defense Documentation Center, and the Clearing House for Federal Scientific and Technical Information. Because there is no simple source of documents indexed in the NASA information system, hard copies of such documents were not always readily obtained within the time and financial constraints of this study. Microfiche copies could be ordered more quickly and at less expense.

It is apparent from our experience that unless careful attention is given to the mechanical and financial aspects of obtaining documents identified in such searches, delays can be encountered in bringing the technology to the potential applier in a usable form. Any operational arrangements for continuing access to the NASA information bank must, therefore, explicitly provide for document supply.

B. TYPES OF MATCHES OBTAINED

An examination of the output of the information systems revealed that the number of "bulls-eye" solutions to specific needs was quite small, although the total number and types of matches with needs was significant. On the whole, results of technology-oriented searches are superior to those designed for a specific need. In several search topics where we had knowledge of specific space-generated technology, we retrieved valuable information; however, in one case (automated chemical analysis) where we had

TABLE 1

SEARCH RESULTS

Search Topic	Reviewed by ADL	Reviewed by KASC	Abstracts Retrieved by KASC	Abstracts Forwarded to ADL
Advanced knitting technology		✓	88	16
Manufacture of inexpensive mattresses		✓	304	53
Microwave communications	✓		210	198
Thermal insulation	✓		244	172
Fiberglass pipe	✓		266	257
Hand tools	✓		150	142
Paints	✓		82	70
Astronaut food for nutrition, preservation, new foods	✓		421	359
Bearings: reduction of maintenance problems	✓		1,240	959
Nitrogen cooling: preserving foods in transport and storage	✓		61	58
Low cost	✓		72	66
Brazil	✓		40	30
Water meters	✓		731	731
Location, navigation and signalling at sea	✓		207	119
Rescue and survival	✓		483	483
Structural materials	✓		1,152	1,152
Packaging	✓		116	116
Solar energy applications	✓		1,261	1,261
Batteries - reliable power supplies for small systems	✓		686	686
Medicine, health and hygiene	✓		5,041	5,041
Shop techniques	✓		5,154	5,154
Information systems	✓		258	2
Video devices applicable to Brazilian educational facilities		✓	754	50
Petrochemicals		✓	470	30
Public health and sanitation		✓	841	39
Timber resources		✓	934	39
Oil shale		✓	315	20
Tires and rubber products		✓	139	20

Source: Arthur D. Little, Inc.

knowledge of specific work accomplished, abstracts were not retrieved through established search strategies. This indicates that present strategies can not be expected to be completely effective in disclosing all potentially feasible matches. Finding matches at a systems level (e.g., food processing techniques) was more productive than seeking a solution to a known problem at a nuts-and-bolts level (e.g., water meters to permit equitable pricing of water for irrigation systems).

We found that we could not expect the information system to be discriminating. Most search strategies produced a substantial amount of extraneous information. However, too confining search strategies often excluded valuable information. Technologists found that information specialists can estimate the volume of abstracts that will be obtained under a given term or combination of terms. Technologists could request search strategies to be designed either to restrict or to include most of the abstracts relevant to a search topic. The present information system could be modified to associate from a problem statement to index terms, and to assess relevance. Close interactions among information specialists at RDC's, their subject specialists, and technologists are essential to achieve the best results.

On the basis of our experience with the NASA information systems, we have learned the following:

1) With the search strategies we used, technology-oriented searches provided a broad range of relevant abstracts. Need-based searches provided a much narrower range; in one case (laws and regulations), only one abstract of small relevance was uncovered.
2) The culling of abstracts uncovered in a typical search is time-consuming. Because all abstracts are in English, transfer would be impeded if investigators were not fluent in the English technical language.
3) Association lists designed for one segment of technology do not directly correlate with another segment.
4) An experienced literature searcher can suggest topics and, through the use of STAR, can quickly point out interesting candidate abstracts for subsequent evaluation by technologists. Intelligent browsing through the literature is a valuable supplement to computerized search.

5) In general, abstracts provide an adequate basis for initial determination of the existence of a potential match. The complete documents would be required, however, if actions were to be taken to implement the matches.

6) Abstracts which have specific information on principles, development status, application results, costs, and practicality were very useful and their potential relevance could be better evaluated. Computer printout of titles of documents and key words do not provide enough information.

7) Evaluation of abstracts would be easiest if reference to related abstracts could be provided; e.g., a patent should cite related patents to inform the searchers of prior or contemporary art.

C. SELECTED MATCHES

The judgments of technologists at the RDC's and ADL were applied to decide the relevance of technology to Brazil's needs, its potential significance in terms of benefits to the population, the economic feasibility of projects for the private sector, and the possibility of obtaining Brazilian Government support to stimulate activity in important areas.

Further analyses identified particular technologies that would serve as useful examples of matching technologies with needs. The examples were chosen to be representative of the general categories of Brazilian needs outlined in Appendix A.

The abstracts do not distinguish among present applied technology, speculative concepts, and future technology. To supplement the abstracts, we obtained information on operational elements, gross parameters, practical application, and costs where possible. This information was included in the discussion of the abstracts to indicate the feasibility of the selected matches. The following matches should be looked upon as examples of the possible uses of documented technology within the NASA information system to establish the feasibility of the application of space-generated technology to the technology needs of Brazil.

1. Agriculture

a. Forest Fire Detector

Abstract:

N65-33592 Idaho Univ., Moscow, Idaho

PORTABLE LOW COST DETECTOR FOR LATENT FOREST FIRES

Everett M. Baily and William R. Parish, Mich. Univ. Proc. of the 3rd Symp. on Remote Sensing of Environment, Feb. 1965 p. 649-666 refs (See N65-33550 22-13)

The discovery of latent forest fires in their early stages or of hangover fires during mop-up operation is of prime importance to the preservation of our timber and watershed resources. This paper discusses the design and construction of a simple-to-operate, portable, rugged, and inexpensive infrared detector to accomplish the above objectives.

Discussion:

Forest fire prevention and suppression is a critical part of forest land management in areas subject to periods of low humidity. Such protection is important in the valuable forest plantations of southern Brazil. Fire control is particularly difficult in the drier regions of Brazil because of the traditional use of fire in agriculture - namely, for clearing forest or brush land, for removing crop residue such as corn stalks, and for preparing sugar cane for harvest. Not infrequently these fires burn more than the intended area. Constant visual inspection of endangered forest land is difficult for large ownerships in areas with rolling topography, where a fire hidden by a hill has a chance to become uncontrollable before the smoke is visible to a distant lookout.

Under these conditions the use of automatic detection stations using radio waves to signal the existence of a fire in its incipient stage can be particularly valuable. Early discovery and communication to a central fire control center permits rapid control using a minimum of fire suppression equipment and manpower, while at the same time minimizing the damage done to the forest resource.

A prototype of the portable, low cost forest fire detector was constructed and tested to establish the usefulness and effectiveness of the device. The tests were made with glowing charcoal briquettes placed in and around small vegetation typical of forest ground cover. A searcher using the infrared device was directed to the general area, defined as being about 300 feet square, to locate the actual target. The briquettes were located in every trial before being seen by the eye. Only about 30 feet separated the searcher from the target, but on the other hand the targets were considerably smaller than those that would exist under actual conditions. The range of this device could be extended to several thousand feet. Its cost is estimated to be about $250. Other known advances in infrared detection technology indicate that latent forest fire detectors could be developed to meet the needs of forest land management.

b. Fiberglass Pipe

Abstract #1:

N67 12896 Royal Aircraft Establishment, Farnborough (England)
THE TECHNOLOGY OF GLASS FILAMENT WINDING (LA TECHNOLOGIE DU BOBINAGE DU FIL DE VERRE)
Georges Jube, Jul. 1966, 31 p, transl. into English from Air. Tech. (Boulogne) No. 3, p. 122-136

The problems of producing filament-wound structures are considered with particular reference to rocket motor casings. The advantages of isotensoidal lay-up are suggested, and an apparatus developed to study its adaptation is described. Helical and polar winding machines are studied and criteria offered to allow choice between them. Mandrels have been developed; light alloy mandrels and soluble mandrels of sand and polyvinyl alcohol appear preferable. Problems of inspection and control at all stages of manufacture are considered in detail.

Abstract #2:

Business Week, March 2, 1968, p. 118-120

BRINGING SPACE DOWN TO EARTH

A California company, deeply involved in the space program, finds that a process for turning out rocket cases can be adapted to produce water pipes for commercial market.

Discussion

Large-diameter, solid-propellant rocket engines require fiberglass cases formed by long glass filaments impregnated with a resin as they are wrapped around a core. The technologies associated with these developments could be applied to fiberglass pipes for irrigation and drainage systems.

Fiberglass irrigation pipe can be made in 20-foot sections, so there are fewer joints and fewer leaks. Fiberglass will not decay and is unaffected by corrosive acids. Unlike ceramic, concrete, or asbestos cement pipes, fiberglass pipe is not brittle. It costs about $12 a foot for the 24-inch-diameter size -- the same as pipe made of other substances. A major saving comes in shipping the pipes because of their low weight and less damage in handling; in view of the distances which have to be covered in Brazil, these properties may be of considerable economic importance.

c. Weather Forecasting

Abstract:

N62-15040 Rand Corp., Santa Monica, Calif.
THE UTILITY OF WEATHER FORECASTS TO THE RAISIN INDUSTRY
L.L. Kolb and R.R. Rapp, repr. from J. Appl. Meteorology, Vol. 1, No. 1, Mar. 1962, p. 8-12, 8 refs. For abstract see N62-11708
06-12
(NASA Contract NASw-103)

It is not possible to state at present just how much economic value either is derived or could be derived from present weather forecasts. It is, however, possible to analyze the weather factors that affect an industry. In this paper, the practices of the raisin-drying industry are found to agree with a theoretical optimum derived from climatological data. The paper goes on to show that weather forecasts properly tailored to this industry may be usable in maxi-

mizing gains and minimizing losses.

Discussion

Increased productivity can be obtained by understanding the effects of climate on specific crops.

d. Irrigation Pumps

Abstract:

N67-34619 Marine Engineering Lab., Annapolis, Md.
BEARING MATERIALS FOR WATER LUBRICATION
Paul Lagally, Mar. 1967, 34 p., refs.
(MEL 103/67; AD-654177) CFSTI: HC $3.00/MF $0.65

Isotactic polybutene in contact with a bronze journal was investigated as a bearing material combination for water lubrication. Aliphatic alcohols were used as model substances for protonic lubricants. The fact that even methanol is a better lubricant than water, in spite of its lower viscosity, is attributed to the lower degree of association. Stick-slip motions indicate boundary lubrication of varying degree. Although polybutene compares favorably with many other organic bearing materials, results of this study indicate that wettability with water is a requirement for further improvement. New bearing material designs for water lubrication are proposed.

Discussion:

As part of irrigation technology, pumps capable of long-term operation without maintenance are essential. The use of bearing materials specially selected for water lubrication should prolong the life of these pumps.

e. Food Preservation

Abstract:

N64-12968 Univ. of California, Davis, Calif.
RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES
Annual Report, 1 Feb. 1962 - 30 Jan. 1963
Washington, AEC Div. of Tech. Inform., 15 Oct. 1963, 184 p, refs.
(Contract AR(11-1)-34)
(TID-19206) OTS: $2.75

The application of ionizing radiation in conjunction with post-harvest procedures is discussed as a possible means of controlling deleterious pathological, physiological, and morphological phenomena in fruits and vegetables in an attempt to extend the shelf life of the fruits and vegetables. The methods employed are given along with the results which have occurred.

Discussion:

An alternative in preserving perishables is ionizing radiation. Although radiation technology is relatively recent and practical applications are insufficient, the developments which are envisaged could make Brazilian agricultural products more available in the consumer and export markets.

However, the following conditions must be met before irradiation can become a practical technology:

1) There must be no major loss in nutritional quality of the product as a result of irradiation.
2) Radiation-induced changes in texture must not make the commodity excessively susceptible to impact and vibration injuries during shipment by rail or truck, or adversely affect its palatability.
3) Radiation-induced flavors and odors must not be objectionable, and, preferably, should not make the product atypical of the species and/or variety.
4) Appearance of the irradiated product must be attractive and, preferably, typical of the species and/or variety.
5) There must be no radiation-induced substances harmful to humans.
6) The postirradiation susceptibility of the product to infections by decay organisms must not be enhanced.
7) Methods for irradiation treatment must not entail extensive additional handling of the commodity.

8) The refrigeration requirement for the irradiated commodity must not be excessive.

9) The cost of the technology must not exceed the benefits to be gained; certainly it must not result in a major increase in price of the commodity to the consumer.

Research has shown that irradiation will not be an all-inclusive technology for fruits and vegetables. If it has a role, it will likely be confined to a limited number of species, and perhaps varieties within species. Even more specifically, it may in some cases be limited to certain physiological stages of the species and/or variety.

f. Special Food Forms

Abstract #1:

N66-29149 Pillsbury Mills, Inc. Minneapolis, Minn.
FORMULATION AND FABRICATION OF FOOD BARS
Final Report, March 30, 1962 - March 20, 1963
Jack R. Durst, Natick, Mass. Army Natick Labs, February, 1966.
55 p.
(Contract DA-19-129-OM-1970 (016063))
(TR-66-29-FD FD-39 AD 631996) CFSTI HC $3.00 MF $0.50

Formulation, production, and storage studies of food bars made from various cereal products (wheat flakes, oats, rice crispies, and graham crackers) and beef hash and soup-type bars (split pea, potato flakes) are presented. The basic matrix for the food bars is a stable binder formulated from protein (sodium caseinate), fat (lard flakes), and carbohydrates (sucrose). The binder is spray-dried, admixed with the food component, and compressed into bar form.

Abstract #2:

N62-16472 Southwest Research Institute, San Antonio, Tex.
ENCAPSULATION OF FOODS
Final Report, December, 1960 - February, 1962
Clark E. Scheutz, William E. McMahon, Leon M. Adams, and Winthrop M. Barnes, Wright-Patterson AFB, Ohio, Biomedical Lab., May 1962, 24 p., 6 refs.

(Contract AF 33(616)-7717)
(MRL-TDR-62-53)

The objectives of the research program were to investigate barrier materials (meeting Food and Drug Administration standards) that may be suitable for use in the encapsulation of foods, and to prepare sample capsules of food items for evaluation. The encapsulating material must be capable of maintaining its essential properties and those of the capsule contents under ambient conditions and also in high-temperature and high-vacuum environments. The food in the capsules must remain uncontaminated and highly stable for six months without refrigeration. Foods of low moisture content were encapsulated in two steps, using a soft-shelled capsule with an overwrap. Fudge, poundcake, and brownies were first spray coated. In each case the bite-sized portions were heat-sealed into plastic bags. Foods of moderate moisture content, exemplified by meat, and foods of high moisture content, such as vegetables and fruits, were encapsulated in laminated containers with and overwrap. Extensive development of capsule forms and equipment for filling and sealing will be required to permit manufacture in quantity with assurance of maintaining sterility.

Discussion:

There are good possibilities of producing foodbars from several Brazilian agricultural products. The same is true for encapsulated foods. The most attractive area of application for food technology appears to be in the processing of agricultural products.

Research on food encapsulation has shown that food bars of desired nutritional value can be easily fabricated using simple blending machines and low-pressure molding techniques. Foil pouches have been developed for successfully storing food bars in 100°F, high-humidity atmospheres if the moisture content of the bars is below 5%.

Although used in military and space programs, food bars have found only limited consumer acceptance. The major barriers to large-scale marketing of encapsulated foods have been unsatisfactory taste and texture. Further developments will be required before food bars will be a standard food product, however, the markets for the improved encapsulated foods are expected to be important in Brazil.

The present Brazilian administration has embarked on a major agricultural diversification program, which aims at bringing an end to the production of low-quality coffee and utilizing the available land for planting new crops, especially those with high nutritive value. The president of the Brazilian Coffee Institute (IBC) has stated that "there will be a real need for private capital once the program gets rolling." The new crops are expected to create a need for exporters, packagers, and converter industries.

In the coffee-producing state of Parana, a variety of foods and cotton is growing on nearly 500,000 acres of farmland formerly used for coffee growing. By 1968, IBC expects the area to harvest 2.3 million 60-kilo sacks of corn, 960,000 sacks of beans, 1.1 million sacks of rice, 600,000 sacks of soybeans, 2 million 25-kilo sacks of peanuts, and 7.3 million kilos of cotton.

An example of what can be done with fallow agricultural resources is to be found in the remote northeast of Brazil in the Sao Francisco valley. Here, recently constructed electrification and irrigation projects have fostered the rapid development of productive farming, and this area may well become the heart of Brazil's future harvests of grains, cotton, grapes, onions, and other crops. European strains of wine grape are being introduced. Newly established highways link this area with the markets of Rio and Sao Paulo and make Sao Francisco one of the most progressive and profitable additions to Brazil's agricultural sector.

Two recent $25-million loans from the Inter-American Development Bank are expected to enable expansion of Brazil's food-processing industry by $150 million a year. The funds, administered by the Bank of Brazil, would take the form of credit on easy terms extended to food processing companies for enlarging and improving their facilities.

A Brazilian food-research center jointly financed by United Nations agencies and the Government of Brazil has become almost self-supporting through consultant work for private food firms. Known as the Tropical Food Research and Technology Center, it has been receiving about 400 requests for technical services each year. Projects researched at the Center include ways to can bread, ferment soybean products, preserve avocados, process banana puree, and can grape juice and apple concentrates. New investment by the food industry in pasteurized orange juice, mango canning, and tomato processing has come out of the Center's research. It also studies marketing possibilities.

Such new food technology could be of interest to the Center. Other government agencies that would be interested in new food technology are the Ministry of Agriculture, IBC, and the Brazilian Sugar and Alcohol Institute.

2. Public Health

Abstract:

N67-28787 George Washington Univ., Washington, D. C.
Biological Sciences Communication Project
BIBLIOGRAPHY ON APPLICATIONS OF ETHYLENE OXIDE
Donald E. Wright and Anne K. Serrell, Jun. 1967, 34 p., refs.
(Contract NSR-09-010-027)
(NASA-CR-84827) Cscl 07C

The bibliography is presented for engineers and scientists interested in ethylene oxide sterilization, and specifically in a decontaminating cycle of ETO applied to spacecraft surfaces following environmental testing. A permuted title index and an author index are included:

Discussion:

Ethylene oxide sterilization can find limited application in food processing, hospitals, and in those industries where decontamination of a product is desired. As an alternative to heat sterilization, ethylene oxide can be applied to systems that could not be adequately sterilized by conventional methods because of their size and shape, temperature limit of materials used in construction, or production requirements.

Gaseous ethylene oxide can only be used to reduce bacteriological contamination in dry, heat-sensitive, highly flavored foods such as spices. The Food and Drug Administration prohibits its use on foods with high moisture content.

3. Exploration and Utilization of Natural Resources

Abstract #1:

N67-21287
THE ECONOMIC EFFECTS OF RADIOMETRIC METHODS IN THE PROSPECTING AND EXPLOITATION OF OIL AND GAS DEPOSITS
G. F. Mikheev and N. G. Feitelman, "Uses of Radioactive Isotopes and Nuclear Radiation in the USSR" Volume 4, 1966, p. 48-55
(See N67-21281-10-13) CFSTI HC $3.00/MF $0.65

Criteria for determining the economic efficiency of radiometric techniques are outlined, and ways of achieving these effects are listed. The potential savings in time and money are discussed for several methods, and examples are given:

(1) Gamma ray logging of oil wells revealed new producing fields which yielded an additional 1476 tons of petroleum in 1954 to 1958.

(2) By locating the oil-water boundary, neutron-gamma ray loggings make it possible to determine the water content of a well.

(3) The use of induced activity in perforated wells is economically more effective because it yields good results and prevents considerable losses.

(4) The use of radioactive isotopes permits the selective tapping of thin sandy reservoirs, resulting in increased output.

It is concluded that the perfection of existing methods and the introduction of new ones will have a tremendous effect on the economy of the USSR. This is estimated at 5 to 10 billion rubles in 1965 with an initial investment in radiometric research and manufacturing of 1 to 2 billion rubles.

Abstract #2:

N67-21284 Israel Program for Scientific Translations, Ltd., Jerusalem CURRENT STATE OF RADIOMETRIC METHODS AND THEIR EFFICIENCY IN STUDIES OF THE GEOLOGICAL SECTIONS IN PETROLEUM, GAS, ORE, AND COAL BOREHOLES Yu I Gordeev, A.A. Mukher, and D.M. Srebrodolskii in "The Uses of Radioactive Isotopes and Nuclear Radiation in the USSR," Vol. 4, 1966, p. 29-32 (See N67-21281-10-13) CFSTI HC $3.00/MF $0.65

Radiometric methods are discussed in relation to their effectiveness in determining the nature of the useful mineral resources. Gamma ray logging furnishes qualitative and, to a certain extent, quantitative information on the natural radioactivity of rocks traversed by the boreholes. The log permits a more accurate lithological description of rocks revealed by the borehole and a reliable identification of

pelitomorphic formations. Its most efficient application is in studies of the geological section in holes drilled for oil and gas. Gamma-gamma ray logging shows variations in the density of rocks cut by the borehole. However, its interpretation is fairly difficult. The method is used almost exclusively in coal prospecting boreholes. Neutron-gamma ray logging, when used under favorable conditions, improves the reliability of interpreting diagrams for identifying promising strata. It is used in about 50% of the boreholes drilled for oil and gas. Selective gamma-gamma ray logging is used to study the spectrum of scattered gamma radiation from a source of comparatively soft radiation. Methods using included activity and radioactive isotopes are mentioned briefly.

Publication

NASA CONFERENCE ON SELECTED TECHNOLOGY FOR THE PETROLEUM INDUSTRY
NASA Sp-5053, Lewis Research Center, Cleveland, Ohio, December 8-9, 1965.

Discussion:

Advanced technology for prospecting and exploiting oil and gas is very attractive to Brazil, because the difference between the growing demand for petroleum products and the low domestic output of crude oil is of crucial economic importance. Reasons for the slow development of the oil industry can be found in the Petroleum Law of 1953, which established government monopoly in exploration and exploitation of petroleum. The same law created the National Petroleum Council as a policymaking body and charged PETROBRAS, a government-controlled company, with the execution of the law. The latter has 35,000 employees and an estimated annual business volume of close to $2 billion.

Brazil's petroleum outlook is not good, but better than it used to be. The country must import about three-quarters of its total crude needs, and unless more oil is found within the country, this proportion will mount sharply in the next decade. Petroleum and petroleum product imports currently cost more than $175 million a year.

Government optimism is based largely on the apparent success of exploration by PETROBRAS, which, early in 1965, announced a major oil find at Carmopolis, in the northern state of Sergipe. The government

hopes this strike will be of equal importance with the major production center of Reconcavo, in the state of Bahia, which at present accounts for almost all of Brazil's crude production. Potential reserves at Carmopolis may reach a billion barrels and daily production could exceed 100,000 barrels. Brazil's total present production is about 150,000 barrels a day.

PETROBRAS is giving very close attention to secondary recovery, and equipment for this purpose is being installed at the Candeias, Cassarongo, D. Joao, Buracica, Taquipe, and Agua Grande fields in Bahia. It is estimated that secondary recovery will substantially raise production.

Brazil's requirements for crude petroleum were estimated at 354,000 b/d in 1965. Should production remain static, the imbalance between production and consumption will be aggravated significantly by 1974, when consumption is expected to reach a level of 600,000 b/d. Present recoverable reserves have been estimated at slightly less than 642 million barrels, with 544 million in the Reconcavo fields and the remainder in the states of Alagoas and Sergipe (prior to evaluation of the new Sergipe deposits). In theory, these known reserves would be sufficient to meet the country's requirements for only three years at the estimated consumption level of 1974.

Accordingly, PETROBRAS earmarked a considerable amount of money for research. Its ambitious program included field work by 152 teams per month on surface geology, 119 teams on gravimetry, 156 teams on seismic measurement, and 42 on electro-resistivity. The research is aimed largely at cutting the outlay for exploratory wells, which cost the government up to $150 for each meter drilled in the Reconcavo area.

The work appears to be bearing fruit. Engineers have confirmed the existence of new oil deposits at Carmopolis, Miranga (state of Bahia), and Barreirinha (state of Maranhao), although the commercial value of the Barreirinha strike is yet to be proven.

Advanced technology on the prospecting and exploitation of oil and gas could help PETROBRAS considerably in this research and development effort. PETROBRAS is planning the construction of a Petroleum Research and Development Center in Rio de Janeiro. The preliminary plans will

be finished within a year, and it is expected that construction and acquisition of equipment will start soon after.

4. Industrialization

a. Wood Laminating and Bonding

Abstract #1:

N62-14350 Forest Products Lab., Madison, Wis.
LIST OF PUBLICATIONS ON STRUCTURAL SANDWICH, PLASTIC LAMINATES, AND WOOD-BASE AIRCRAFT COMPONENTS AVAILABLE FROM THE FOREST PRODUCTS LABORATORY, MADISON 5, WIS.
June 1962, 14 p., 296 refs. (RPI-4)

The document contains a list of publications, with accession numbers, for categories of Solid Wood; Plywood and Veneers; Joints and Fasteners; All Wood Laminates; Plastic Laminates; Stabilized Wood and Wood-Resin Laminates; Pulp, Paper, and Lignin Laminates; Adhesives and Glue-Joint Properties; Sandwich Construction; and Pathological and Biological Features.

Abstract #2:

N64-15020 Bundesministerium fur Verkehr., Bonn (W. Germany)
BONDED SOLID- AND LAMINATED WOODS: BEHAVIOR UNDER EXTREME CLIMATIC CONDITIONS AND NONDESTRUCTIVE TESTING
K. Egner, H. Bruning, and H. Kolb (Tech. Hochschul Stuttgart)
Dusseldorf, VDI-Verlag GmbH, 1963, 29 p., refs. (in German)
(Its Luftfahrt-Forschungsberichte 20)

This report, concerning wood for aircraft, contains the following articles: (1) "Tests of Standard Adhesives for Acid Damage and Embrittlement of Straight-Glued Joints in the Case of Solid Wood under Extreme Climatic Conditions"; (2) "The Behavior of Laminated Woods under Extreme Climatic Conditions"; and (3) "The Possibility of Recognizing Wood and Adhesive Defects and Damages by Nondestructive Testing."

Abstract #3:

N66-34127 Rohr Corp., Chula Vista, Calif.
SOME DESIGN CONSIDERATIONS FOR ADHESIVE BONDING
Edward C. Burkart in NASA Marshall Space Flight Center, Structural Adhesive Bonding Conf., 14 Mar. 1966, 19 p.

(See N66-34126 20-15) CFSTI: HC $7.00/MF $2.00

This paper covers some of the design details and materials selection criteria which are important considerations for the designer of bonded structures. The advantages and limitations of bonded structures are discussed along with design suggestions for better utilization of the bonded concept. A comparison between adhesive bonding and mechanical fastening is made in several standard types of construction. The basic concepts of a bonded sandwich are discussed relative to optimizing from both functional and manufacturing standpoints. Suggestions are given for insuring the compatibility of the various elements of a sandwich structure through the proper selection of materials and design configuration. Also included is a brief description of a program presently in existence which investigates the feasibility of substituting adhesive bonding for mechanical fasteners on large rocket thrust structures.

Discussion:

The availability of hardwoods of many different types to the Brazilian furniture and veneer industry provides the raw material which should permit it to expand its markets. This expansion can be accomplished through original designs and improved manufacturing and construction methods. Bonding and lamination will be required to meet the demands of modern styling. These industries could benefit from the work carried out by forest product laboratories and new adhesives developed for a variety of environments.

b. Metalworking

Abstract #1:

N67-26560 Midwest Research Inst., Kansas City, Mo.

HIGH-VELOCITY METALWORKING: A SURVEY

Michael C. Noland, Howard M. Gadberry, John B. Loser, and Eldon C. Sneegas, Washington, NASA, 1967, 187 p., refs.

(NASA-SP-5062) GPO HC $1.25 CFSTI MF $0.65 CSCL 13H

Comparative data are presented on the deformation velocities in high-velocity and conventional metalworking processes. These show that in explosive electrohydraulic and electromagnetic techniques the deformation velocity range is at least one order of magnitude higher

than the ranges of conventional methods. Although there is some overlap for pneumatic-mechanical systems, metallurgical effects appear in work done by this method which are not apparent in conventionally processed parts. Details are given on how these four techniques work, and the equipment and applications to metalworking problems are described. In discussing die and tooling design, attention is centered on high-velocity sheet metal forming dies and high-velocity forging dies. Metal behavior in sheet and plate forming is assessed. Also included is a review of present trends and future prospects for extending the capabilities of the processes.

Publication:

N67-25855 National Aeronautics and Space Administration
Washington, D. C.
SELECTED MACHINING AND METAL FABRICATING TECHNOLOGY - A COMPILATION
1967, 30 p., Prepared by IIT Research Institute
(NASA.SP.5065) GPO HC $0.25 CFSTI MF $0.65 CSCL 13H

Discussion:

New tools and techniques for machining and metal fabricating could be very attractive to the Brazilian metalworking industry. Fastening devices, assembly tools, metal forming techniques, layout and inspection devices, machine setups, fixtures and modifications, and machine tools could be particularly interesting. The threadless fastener, the level alignment tool, the dropped weight center punch, the flycutter set gage and the self-centering reamer for deep holes are also attractive items of technology for Brazil.

The advantage of both surveys to the Brazilian metalworking industry is the stimulation that it can receive through awareness of new technology. The specific technology could find application after this information is made available to metalworking companies.

There are more than 80 such companies in Brazil whose total capital exceeds two billion cruzeiros. The following would be the most receptive to this technology:

Acos Villares S.A., Sao Paulo

Acos Anhanguera S.A., Sao Paulo

Siderurgica J.L. Aliperti, Sao Paulo

Fundicao Tupy, S.A.

Fabrica de Aco Paulista

Metalurgica Matarazzo, Sao Paulo

M. Dedini S.A. - Metalurgica

Metalurgica Barbara, Rio de Janeiro

Bardella S.A. - Industrias Mecanicas, Sao Paulo

Industria de Parafusos Mapri S.A.

Metalurgica Wallig S.A.

Productos Metalurgicos Cargriz S.A.

Perfuradora de Metais S.A.

c. Power Transmission

Abstract #1:

N67-22182

SUMMARY OF THE CURRENT POSITION AND REVIEW OF TRENDS IN EXTRA-HIGH VOLTAGE TRANSMISSION LINES

A. M. Nekrasov in "500 Long Distance Electric Transmission," 1966, p. 1-9 (See N67-22181 11.09) CESTI HC $3.00 MF $0.65

The centralization of electric power production by the development and unification of power systems is shown to be the most effective and economically desirable method of ensuring adequate electric power for consumers. This method permits a better utilization of thermal and hydraulic energy sources, more rational use of power, reduction in the capital cost of the power plant, and a quicker utilization of equipment information gained from the construction and operation of high-voltage transmission lines as well as from research.

Abstract #2:

N67-22181 Israel Program for Scientific Translations, Ltd., Jerusalem

FIVE HUNDRED KV LONG-DISTANCE ELECTRIC TRANSMISSION

A. M. Nekrasov and S. S. Rokotyan (ed), 1966, 591 p., refs, Translation into English of the book "Dalnie Elektroperedachi 500 KV" Moscor Izdatel's stvo Energiya, 1964

CFSTI HC $3.00/MF $0.65

Pertains to the design, manufacture, and maintenance of the equipment and structure used in constructing 500-kv long-distance transmission lines.

Discussion:

Extra-high-voltage transmission lines and 500 kv long-distance electric transmission are very attractive to the Brazilian power companies.

One of the most important goals of the present Brazilian administration is to expand the power-generating capacity of the country to service Brazil's rapid economic development. The lack of adequate coal deposits and the deferred exploitation of oil resources have caused Brazil's electric industry to be developed mostly on the basis of the harnessing of her hydro-potential (incidentially,one of the largest in the world, estimated to be more than 100 million kw). Much of this potential exists on rivers rising on the high escarpment along the Atlantic coast several hundred miles each side of Rio de Janeiro. Most industrial concerns that would like to use cheap electric power coming from the Paulo Afonso hydroelectric project on the Sao Francisco River (Bahia State) find that markets are small in this region; on the other hand, in the areas where the markets are large enough to allow economies of scale, the cost of electric power is high. The technology of bringing electric power with minimum losses in transmission from regions of surplus (Paulo Afonso in Bahia State, Furnas and Estreito in Minas Gerais State, etc.) to power-consuming areas (Sao Paulo, Rio de Janeiro) would help solve one of the country's critical needs.

In 1961 the federal government created the Central Electric Company of Brazil (Centrais Eletricas Brasileiras S.A. - ELETROBRAS) to undertake studies, projects, construction, and operation of generating plants, transmission lines, and distribution of electric energy, and to perform any commercial work connected with these activities throughout the country. The government holds 51% of ELETROBRAS' capital.

Under constitutional provisions, the government exercises jurisdiction over electric power utilities. Through ELETROBRAS it regulates tariffs and, in this connection, may impose taxes and other levies on electric power consumers. It also has jurisdiction over the rights to develop hydroelectric sites on all rivers. Accordingly, it has organized autonomous federal agencies for developing some areas and, in some instances, has granted concessions to develop sites to state utilities

and, in the past, to investor-owned utilities.

This new power transmission technology would be of interest to ELETROBRAS and to the many other state-owned or private power companies interested in electric power transmission.

d. Solar Engines

Abstract:

N65-29014 College of Engineering, Univ. of Florida, Gainesville, Fla.
SOLAR ENGINES PART I: A 1/4 HORSEPOWER CLOSED CYCLE SOLAR HOT-AIR ENGINE. PART II: A 1/3 HORSEPOWER CLOSED CYCLE SOLAR HOT-AIR ENGINE
Erich A. Farber and Ford L. Prescott, Jul. 1965, 13 p., refs
Vol 19, No. 7 (TPR-14)

The operating principle, design, and performance of closed-cycle solar hot-air engines are discussed. The 1/4-horsepower engine has certain advantages in the right environment. It can be mass produced as economically as other engines of similar size, and it is safer, more versatile, more rugged, and has fewer parts. The 1/3-horsepower solar engine shows promise when principally operated by solar energy, possibly supplemented by other fuels. These engines are of the portable or semi-portable type and can, if mass-produced, compete in price with other small, low-cost engines. They are versatile, rugged, safe, quiet, and have no waste products when used with solar energy. They also have relatively few parts, which reduces maintenance requirements and makes maintenance by unskilled personnel possible.

Discussion:

Although the expansion of the Brazilian power transmission and distribution network is progressing, electricity will not be available in some regions for years. Great distances and difficulties of supplying fuel to remote areas suggest that solar energy may be an important alternative power source.

Solar energy is amply available in Brazil's latitudes; therefore, simple and inexpensive engines capable of utilizing solar energy may find important applications.

Both closed- and open-cycle engines* are centuries-old inventions, but not until recent years have effective hot air engines been built. They are considerably simpler than gasoline engines. They have no ignition systems, and the cylinders and pistons are not exposed to high pressures or stresses. Moreover, their few parts mean less maintenance. No special skill is needed to operate them. Mass produced, hot air engines would be less expensive than gasoline engines: their estimated manufacturing cost was $12.50 in 1965.

Although the experimental engines reported on were slow-speed devices (200-300 rpm), more recent work at the University of Florida has demonstrated the feasibility of much higher speeds (1200-1300 rpm). Further, a 1/2-hp, 200-300 rpm hot air engine utilizing wood, low grade oil, charcoal, or solar energy as fuel has recently been studied and shown to have a solar conversion efficiency of 8-10%.

Fractional-horsepower portable hot air engines can find use in irrigation, in operating small machines, and in recharging batteries to supply electrical power for communication, lighting, or electrical motors when solar energy is not available.

5. Housing

a. Corrosion-resistant Coatings

Abstract:

N66-33509 Coating and Chemical Lab, Aberdeen Proving Ground, Md.
TROPICAL EXPOSURE OF FINISHING SYSTEMS FOR FERROUS METALS
Progress Report
Melvin H. Sandler, May 1966, 70 p., refs.
(CCL-197-AD-63416) CFSTI HC $2.00/MF $0.75

The report covers a study of the corrosion protection afforded to ferrous metal under tropical exposure conditions by 28 paint systems covered by Military Standard 171, "Finishing of Wood and Metal Surfaces." Also included were four systems using an experimental epoxy primer and one with an experimental thermoset acrylic top coat. The coatings were

*A closed-cycle solar engine is inherently slow; an open-cycle engine runs about five times as fast.

applied over solvent-cleaned steel, as well as metal pretreatments conforming to types I, II, and III of Federal Specification TT-C-490, "Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings."

Test specimens were exposed in the Panama Canal Zone at breakwater, open field, and rain forest sites. Another set was exposed concurrently at Aberdeen Proving Ground. After 21 months' exposure, test data showed zinc phosphate conforming to TT-C-490 type I to be the most effective pretreatment and that with the exception of control of corrosion in areas at seacoast sites. Many of the current finishing systems will provide a high degree of corrosion protection under various types of climatic exposure. The exact duration of this protection remains to be determined by additional long-term exposure of the more effective systems.

Discussion:

Improved finishing systems for ferrous metals are required by the Brazilian paint industry. Along the coast of Brazil, where a considerable portion of the population and industries are located, corrosion is a severe problem, and corrosion protection of ferrous metal is of considerable economic significance.

Rust-inhibiting enamels applied as a two-coat system have been demonstrated as adequate for corrosion protection in a seacoast atmosphere. Many of these enamels should be effective for at least five years. However, there is a need to improve the corrosion protection of metals whose coating has been damaged; this can be acomplished through the development of improved metal pretreatments and/or primer systems.

b. Heat-reflecting Paint

Abstract:

N66-13437 Army Coating and Chemical Lab., Aberdeen Proving Ground, Md.
DEVELOPMENT OF AN OLIVE DRAB SOLAR HEAT REFLECTING AND LOW VISIBILITY ENAMEL. Final Report
Melvin H. Sandler, 4 Oct. 1965, 32 p., ref.
(CCL-188. AD473571)

This report covers the development of an olive drab solar heat reflectant and low-visibility enamel for use on missiles and related

ground support equipment such as instrument trailers and vans. This enamel provides higher solar heat reflectance than any other dark shade enamels, is relatively inexpensive, and has an olive drab color.

Discussion:

High solar heat reflectance paint is of great practical importance for vehicles exposed to the tropical sun to provide a higher degree of comfort to the operator. In addition, it permits metal roofs or walls of structures to provide better shielding in both private and public buildings. Such paint could be used very widely in school buildings and factories to provide a better working environment.

The development of a low-visibility enamel with a high infrared reflectance resulted in a product which costs $7 per gallon, which is $4 per gallon more than conventional enamel but about $10 less than other infrared-reflecting, low-visibility enamels. The maximum surface temperatures attained with the new paint averaged 9.5°F less than the higher price product, 57°F less than the conventional low-visibility enamel, but only 9.7°F higher than white enamel.

c. Inorganic Paints

Tech Brief 65-10156

DURABLE, FIREPROOF, EASY TO APPLY INORGANIC PAINT

Discussion:

This completely inorganic paint is formulated with an alkali-metal silicate solution (e.g., a water solution of potassium silicate) as a vehicle, a phosphate (e.g., aluminum orthophosphate) as a wetting agent, a pigment (e.g., titanium dioxide) as a coloring agent and filler, and water as a thinner. Various other inorganic materials, including standard pigments, can be added to or substituted in the basic formulation to obtain paints having a wide range of desirable characteristics for special applications.

The paints can be applied directly to various materials, including aluminum, steel, plastics, and ceramics, by conventional methods, such as spraying, brushing, and dipping. Painted surfaces can be air dried at room temperature or elevated temperatures. Stainless steels and certain plastics require the use of a primer coat to ensure proper

adhesion of the paint. In some cases a sealant can be applied over the paint to eliminate porosity and improve water resistance. Appropriate primer and sealer compositions have been developed for special applications. Fifteen different inorganic paint and primer compositions in this series have been formulated and tested. These paints, which are simply and inexpensively prepared in a variety of colors, have excellent shelf life and are easily applied to provide coatings that are generally stable, fireproof, adherent under wide temperature fluctuations, waterproof, hard, and tough.

d. Brazil's Paint Industry

The nine most important paint producers (of a total of 100) are:

Tintas Ypiranga S.A., Rio de Janeiro	+15,000 tons/year
Tintas Coral S.A., Sao Paulo	+ 7,500
Sherwin-Williams do Brasil, Sao Paulo	
Tintas e Vernizes, Sao Paulo	
Goyania S.A., Sao Paulo	
Super, Sao Paulo	
Nitro-Quimica, Sao Paulo	
Renner Hermann, Porto Alegre	
American Marietta, Santo Amaro	

Statistics on the paint industry are few. However, we estimate that over 100,000 tons of paints are produced in Brazil each year. The major producers listed above account for about 90% of all sales in Brazil.

The paint industry is almost completely self-sufficient and quite advanced. Whereas auto companies and some appliance manufacturers have had trouble with locally made paint, they have worked out satisfactory solutions with local manufacturers. Only rarely is it necessary to import special paints.

About 60% of the paint consumed is oil-based. Another 20% is synthetic enamel, including alkyds and a small amount of epoxies. The remaining 20% is water-based -- butadiene rubber, PVC, casein, and a small amount of acrylics. About 70% of the paint market is domestic and commercial trade sales.

The homes of the lower income groups are usually whitewashed. Homes of the higher income group are professionally painted with oil-base paints. Thus

the emulsion-type paints such as SBR, casein, acrylics, and polyvinyl acetate base have not yet penetrated the trade sales markets to any extent. Probably not more than 15,000 tons of latex paints are sold each year. However, future prospects for polyvinyl acetate base emulsion paints appear to be good.

It is estimated that industrial paints account for more than 30% of the total market and most of the synthetic paint market. The largest end-uses are for automobiles and appliances; these are generally alkyd resins or alkyd-melamine resins, although one auto manufacturer is using nitrocellulose lacquers.

The market for paints that offer corrosion and solar heat protection is large. If the technology proves to meet Brazil's needs, there are no obstacles to its successful implementation.

6. Education and Training

Abstract #1:

N66-37272 Documentation, Inc., College Park, Md.
THE INTRODUCTION OF MICROFICHE FOR DISSEMINATING TECHNICAL INFORMATION IN THE UNITED STATES
Douglas S. Price, May 1966, 28 p.
(Contract NASw-1315)
(NASA CR-62032)

The development of an economical, reproducible, and convenient flat microfilm format that can be used and enlarged on existing equipment is described. The microfiche format, virtually unknown in the country in 1961, was selected as the most feasible means of meeting NASA's specifications for an easily read microform unit that comprised a single report and permitted reproduction both of additional copies of the microform and of original-size reproductions of the report.

Production of a 5 x 8 microfiche was initiated for NASA in 1962. Factors leading to the selection of size and reduction ratios, the use of diazo film as the sensitive medium, and the standardization of the microfiche format are discussed. The evolution of camera modifications, film processing, and make-up techniques for quantity production is described. Although some technical problems remain, the NASA Scientific and Technical Information Facility produced over 5 million high-

quality microfiches of reports in 1965. The adoption of the 105 x 148 mm microfiche format standard by government and industry insures its continued expanded use and provides a ready market for developers of microfiche equipment.

Discussion:

Implicit in the technology transfer process is the availability and communication of information to the receiver. NASA's Scientific and Technical Information System can be adapted to meet Brazil's technical information needs. Microfiche seems especially useful. Microfiche could be the backbone of Regional Dissemination Centers (similar to those in the United States) or used with other forms of information exchange to make documents readily available at low cost to Brazilian requestors.

The customer cost of microfiche copies of reports from the Clearinghouse for Scientific and Technical Information of the U. S. Department of Commerce is $0.65 versus $3.00 for paper copies. The simplest microfiche readers can be purchased for $90, but a reader/printer costs about $13,000.

Abstract:

N67-34432 Stanford University, California Institute for Mathematical Studies in the Social Sciences

SPELLING DRILLS USING A COMPUTER-ASSISTED INSTRUCTIONAL SYSTEM

Jack M. Knutson, June 30, 1967, 81 p., refs.

(Grant NGR-05-020-036)

(NASA CR 87482 TR 112) CFSTI HC $3.00 MF $0.65 CSCL 05J

The feasibility of using computer-assisted drill and practice instruction as both a pedagogical and research tool was studied. Two main methods were followed: 1) the number and spacing of repetitions on error items were varied to determine the effects on learning of new spelling words in a drill context, and, 2) the effect of student confidence estimates in the correctness of his response was investigated. Subjects were 42 culturally disadvantaged elementary school students. A modified digital computer with a variety of input and output devices was included in the instruction equipment. Word list selection, construction, administration, and grading procedures are described in detail. Response data

are analyzed on an individual and group basis, and consideration is given to group differences and time and testing variables. Overall analysis indicates that repetition of error words generally led to greater learning. Confidence rating results tenuously suggest that confidence ratings and the probability of a correct response are related in an orderly linear fashion.

Discussion:

In carrying out the Brazilian Government's educational program, certain specialized institutions have been of outstanding service, both in educational studies and research and in special teaching.

The National Institute for Pedagogic Studies (INEP) was founded in July 1938 to carry out research into educational systems and to formulate the most suitable system for Brazil. This Institute, which is under the Ministry of Education and Culture, is responsible for advanced training courses for primary and normal teachers as well as for training supervisors, and is financed by the National Primary Education Fund. It also controls the Educational Research Centers of Rio de Janeiro and five Regional Centers in the states of Bahia, Rio Grande do Sul, Sao Paulo, Minas Gerais, and Pernambuco, all concerned with improved methods of teaching and teacher training. Besides bulletins, the INEP publishes the thrice-yearly Brazilian Pedagogic Studies Review and runs the Murillo Braga Library and the Pedagogic Museum.

The Brazilian Educational Studies Center (CBPE) was founded in 1955 with the following objectives:

- The study of the cultural and educational characteristics, and their development, in each region of Brazil and in the country as a whole; this aims at the gradual elaboration of an overall educational policy for the whole country;
- The preparation of plans, recommendations, and suggestions for revising and reconstructing the educational system at the elementary, secondary, and advanced levels, as well as in the field of adult education;
- The preparation of textbooks, manuals, and teaching materials, and the carrying out of special studies in school

administration, curricula, educational psychology, the philosophy of education, testing, and other subjects related to the improvement of education; and

. The training of school administrators, educational specialists, and teachers for normal and primary schools.

The CBPE publishes a review, "Education and Social Sciences," three times a year, which gives the results of research and studies carried out by the center and a Bibliography of Brazilian Education.

The publishers of Cruzeiro and Manchete have shown great interest in literacy campaigns in Brazil, and some of them could help publicize their technology.

The concept of using computer-assisted drill and practice instruction appears to meet a real need. Computer manufacturing companies that are established in Brazil, such as IBM, UNIVAC, Remington Rand, and Burroughs, could play an important role in putting programs of this type into practice.

7. Communication

a. Power Sources

Abstract #1:

N66-15253 Joint Publications Research Service, Washington, D. C.
POWER PLANT TO CONVERT SOLAR ENERGY INTO ELECTRICITY
A. P. Landsman, M. D. Yagudayev, N. V. Shavrin, and Yu. M. Yuabov
in "Heliotechnology," 21 Dec. 1965, p. 12-17, refs. (see N66-15251 06-03)
CFSTI: $3.00

A power plant for converting solar energy to electricity was produced which has an average output of 150 watts. The plant uses a solar parabolic cylindrical concentrator and a silicon photobattery. The device has been tested and failure-free operation of the entire system has been demonstrated. Energy conversion efficiency can be improved if photoconverters are used whose voltage and current-temperature characteristics are better than those of the presently used silicon photocells (e.g., photocells of gallium arsenide). In addition, a silicon photobattery almost 2sq m in area is needed to produce a current of 150 watts under ordinary illumination. Its cost is also very high.

Abstract #2:

N67-23038 Electronics Div., Atomic Energy Center, Lahore (Pakistan)

RURAL ELECTRIFICATION, A GENERAL REPORT

F. A. Afzal, Mar. 1966, 23 p.

(PAECL/SOL-3) CFSTI: $3.00

A discussion is given of the electrification of rural homes in Pakistan by utilizing solar cells and storage batteries. Included in the discussion are topics devoted to the merits, disadvantages, technical details, and economical feasibility of the system.

Abstract #3:

N67-10263 National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio

BATTERIES AND FUEL CELLS

J. Schwartz, J. Fordyce, B. King, M. McKee, G. Soltis et al. in "Space Power Systems Advanced Technol. Conf.," 1966, p. 9-51, refs. (See N67-10261 01-03) CFSTI: HC $3.75/MF $1.50

Efforts to improve electrochemical systems in areas of energy density, life, temperature capability, and reliability are related. Improved performance and efficiency in the nickel-cadmium and silver-zinc cells are discussed. In the nickel-cadmium battery the persistent problem considered is loss of charge on the nickel-oxide electrode on standing at open circuit. Shortcomings of the silver-zinc couple are listed as soluble electrodes, separators not inert to their environment, and zinc electrode susceptible to dendritic growth. High- and low-temperature batteries and methods of coping with extreme thermal environments are described as the main problems in exploration of the surfaces of Mercury, Venus, and Mars. Non-aqueous batteries that offer promise of major increases in energy density are considered on the criteria of good stability and conductivity and low viscosity. Practical test results involving anodes, cathodes, and electrolytes are illustrated in tabular form. Development of electrode materials capable of high power output and long life is termed the critical area with respect to fuel cells.

Discussion:

The interstate toll network needs greater capacity and reliability.

Improved system capacity and quality of transmission can assist in the expansion of the communication network. The requirements of the interstate toll systems between cities in the northern section of the country, which are separated by large distances and have little or no roads or electrical distribution networks, point to the need for a new approach to system design.

The conversion and storage of solar energy by solar cells and fuel cells would be an attractive power source for remote areas. Present microwave systems with advanced solid-state circuitry require little power for operation other than for the final traveling wave tube in the output stage.

The use of these techniques should produce a low-cost system that could be constructed in remote areas, be self-sustaining, and require little maintenance. The northeast region of the country has an abundance of sunlight and should be ideal for this type of system.

b. Signal Transmission

Abstract #1:

N67-26807 Postmaster-General's Dept., Melbourne (Australia)
PROTECTION OF TELEPHONE CABLES FROM ATTACK BY INSECTS
G. Flatau [1966] 19 p., refs., presented at the 15th Ann. Wire and Cable Symp., Atlantic City, 7-9 Dec. 1966
(AD-646543) CFSTI: HC $3.00/MF $0.65

As a result of testing carried out in Australia over the past 15-20 years, an attempt was made to classify cable sheathing materials into four groups, as far as their resistance to insect attack is concerned: 1) fully resistant materials: steel, brass, copper, aluminum, bronze, polycarbonate, acetals; 2) highly resistant materials: rigid PVC, high-density polythene, nylon, PTFE, polyesters; 3) moderately resistant materials: lead, polypropylene, polyurethane, some natural rubbers, ABS; and 4) non-resistant materials: low-density polythene, plasticized PVC, cellulose acetate butyrate, synthetic rubbers. No general solution for the protection of telephone cables from insects is yet in existence, but present knowledge is now far enough advanced to permit the specification of cable sheathing materials which will stand an excellent chance of resisting attack under the most hazardous conditions. The final selection will usually be a compromise between economic

and performance factors, and hence a knowledge of the probability of attack in a given area is required, when such decisions are to be made.

Discussion:

The northern sections of the country, particularly those areas that border on the Amazon River, are tropical rain forests. The combination of heat and moisture has produced almost impenetrable vegetation and ideal breeding conditions for insects and vermin. As a result, no large scale development of the vast natural resources located in this region has been possible. Civilization has been limited to coastal towns and inland sites that are accessible to river transportation. In these areas the telephone plant has also been almost entirely within the major cities, e.g., of 2974 telephones located in the state of Amazonas, 2957 are in the state capitol of Manaus.

Any major exploitation of the natural resources will require efficient, reliable communication and extended growth of the present telephone plant beyond the cities. The use of insect-resistant cable should assure improved system compatibility with the existing environment.

Cable for the communication system is currently being produced in Brazil at the rate of 400 million conductor meters per year. Techniques and materials discussed in this publication should assist in providing better protection for cables.

Abstract #2:

N66-39058 Joint Publications Research Service, Washington, D. C.
SPECIAL FEATURES OF DEVELOPMENT OF THE TECHNIQUES AND EQUIPMENT FOR CONSTRUCTION OF SWITCHING STATIONS
R. K. Kvrivishvili and A. D. Kharkevich in 22nd All-Union Sci. Sessions Devoted to Radio Day, Sect. on Wire Commun., 9 Sept. 1966, p. 13-18, refs. (See N66-39055 24-07) CFSTI: $3.00

An analysis is made of the components of various commutation systems developed in the United States and the USSR which employ quasielectronic or electronic switching devices, and mention is made of some of the techniques and equipment necessary for network construction. The examples deal with: 1) telephone communications and information transmission and 2) network capabilities, control equipment, and switching devices.

Discussion:

Switching systems in the telephone plant in Brazil at the present time are in need of improvement in the southeast, while in the north toll switching is practically nonexistent. On interstate toll circuits using HF radio, all circuits are now manually switched through Rio de Janeiro, a procedure that further reduces the quality of service.

The government has taken steps to give overall direction to the nationwide telecommunication system; the First Telecommunication Congress was held in Rio de Janeiro, in June 1966, to discuss these problems and to plan the required steps.

The rate of industrialization and the attendant growth in communications will require the installation of high-capacity routes farther out from the Rio San Paulo area in the near future; this may require planning for a nationwide dialing and switching system, because the growth in traffic will soon exceed practical capabilities of the manual system. Rio de Janeiro and San Paulo now have over 250 switchboard positions, and further expansion is necessary. Decentralized switching and a nationwide network plan will assist in improving communications systems.

Abstract #3:

A66-22696

COMMUNICATING WITH MICROWAVES

Winston E. Kock (NASA Electronics Research Center, Cambridge, Mass.)

Physics Teacher, Vol 3, Nov. 1965, p. 2-6

Short account of the use of microwave radio relay techniques for communications. The message-handling capacity of telephone systems has been steadily increased as the need for communication increased. The first important improvement in bandwidth resulted from the development of a technique (carrier telephony) by which more than one speech channel could be carried over one pair of wires. Coaxial cables were then introduced, which offered a significant bandwidth improvement over the earlier two-wire transmission line. The most recent step was to use microwave radio in telephone circuits. Microwaves were seen as a way to overcome the frequency-confining effect of wire lines. The line-of-sight requirement is discussed, and microwave lenses are described. The use of microwave satellites for telephone and television communications is discussed. The problems confronting the designers of com-

munication systems for deep space probes are considered. Possibilities for communicating with laser light waves are discussed.

Discussion:

While the present interstate toll system has some microwave links on the high-density routes in the southeast, the main bulk of the system still relies on HF radio. This structure can no longer sustain the ever-increasing traffic. Conversion to higher density systems is now required; microwave is the most logical solution, in view of the needs and the geography.

Microwave is most suitable for high-capacity systems that must transmit telephone and television signals, as in Brazil. The geography of the country is ideal for microwave systems: high plateaus constrain most of the population to a narrow strip 60-80 miles wide on the east coast, and developments are clustered. The next 10 years should see the conversion of HG radio to microwave for most of this route. The documents referenced above should be most helpful in assisting planners of that system.

c. Reliability

Abstract #1:

N66-21479 Semiconductor Products Div., Motorola, Inc., Phoenix, Arizona
PRODUCTION ENGINEERING MEASURE FOR SILICON LINEAR INTEGRATED CIRCUITS
Quarterly Progress Report
Robert McGinnis, Thomas Quaid, and John Hatchett, 1965, 47 p.
(Contract DA-36-039-AMC-06158 (E))

This report describes the work accomplished during the first quarterly period in the effort to eventually produce silicon linear integrated circuits of the type used in FM receivers. Most of the effort was devoted to developing the receiver back-end circuits; i.e., the circuits that follow the i-f filter. During the first quarter, circuits designed to replace the IC500 (i-f amplifier), IC501 (limiter), IC502 (squelch), and IC503 (audio amplifier) were breadboarded and tested. The receiver back-end circuits comprise a conventional circuit discriminator and three integrated circuits: 1) i-f amplifier: the four i-f amplifier stages are to be packaged in two TO-5 cans with two amplifier

stages occupying the same chip; 2) limiter/squelch: occupying the same chip will be the limiter, the squelch noise amplifiers, and the squelch switch; 3) audio amplifier: a class B push-pull amplifier.

Abstract #2:

N66-10238 Radio Corp. of America, Princeton, New Jersey

RELIABILITY PROGRAM

H. F. Wuerffel, R. A. Smith, L. Gomberg, and D. F. Metz, 1965, p. 261-271 (Contract NAS5-1272)

Component part reliability, system reliability analysis, conservative design, rigorous testing, and quality control provided the basis for the overall reliability program for Relay I. A description is given of the spacecraft mission profile and the parts program. It is emphasized that redundancy was incorporated at all levels of the development program to determine the reliability of the spacecraft. Two separate models and a composite of the two were developed to determine the reliability of three modes of transmission. Malfunction data reporting and analysis were made to determine if the final product had the reliability designed into the circuit and to eliminate problems arising from design, system integration, and testing. In spite of these preliminary tests, the inability to turn off one of the highpower regulators and its associated wideband repeater was not discovered until the Relay spacecraft was in orbit. This malfunction was related to excessive reverse leakage current and dew point. Vendor control, preconditioning, product quality control, manufacturing environment, handling and log books are discussed.

Discussion:

Production of telephone equipment in Brazil is carried on by five different companies, who make all elements from cables to complex microwave repeater systems. With the critical shortage of skilled manpower and an increasing demand for more output to expand new plants and modernize old ones, efficient and automated methods of production should be considered.

The production of telephone hardware with integrated circuits is within the capabilities of Brazilian industry. Production of large quantities of the same design, as required in a telephone system, is ideally suited to mass production techniques using integrated circuits. Western Electric

is now heavily committed to produce future systems by this method and anticipates substantial savings with an increase in reliability. Brazil could benefit substantially by considering this approach to future production needs.

The cost of setting up an integrated circuit manufacturing and marketing facility is estimated at $5-10 million. The cost of a small-scale integrated circuit production line can be as low as $500,000.

The price of integrated circuits has dropped from an average of $20 in 1966 to $2.50 in 1968 and is expected to level off at about $1 in the near future. With such a reduction in cost, the use of integrated circuits has increased dramatically, and a growth of 30% per year is projected through 1970 in the United States.

8. Transportation

a. Refrigerated Transport

Abstract:

N64-26017 Cyrogenic Development Lab., Linde Co., N. Y.
LIQUID NITROGEN: AN ALL PURPOSE EXPENDABLE REFRIGERANT
Frank Notaro in Am. Soc. of Heating, Refrig.,and Air-Conditioning Engr., "The Role Cyrog. is Playing in Expanding Mech. Eng." (1963), p. 32-52, refs. (See N64-26014 18-13) NBS. Boulder, Colo.

Liquid nitrogen is the most promising element of "canned" refrigeration. Along with its promise of refrigeration economy, it offers performance characteristics unmatched by standard methods of refrigeration -- specifically, it offers effective and efficient distribution of refrigeration over a wide range of refrigeration requirements, extremely high reliability, and quiet operation. The typical liquid nitrogen system (consisting of a suitable nitrogen supply, a nitrogen distributor, and a simple temperature controller) finds wide application where total yearly refrigeration requirements do not economically justify high investments for equipment, where flexibility is required to accommodate large peak demands, or where effective control of temperature is required for ranges from less than -100°F to ambient conditions.

Liquid nitrogen in-transit refrigeration was initially proposed for use with vehicles engaged in the local delivery of food, where recovery

of cargo space temperature following deliveries poses a most severe performance requirement. It is presently being extended in its application to intermediate and long haul operations for both frozen and perishable foods. The effectiveness and economy of liquid nitrogen refrigeration depend primarily on fleet operating practices, thermal characteristics of cargo, and thermal characteristics of the vehicle.

Discussion:

Transporting perishables from producers to consumers, or to a port of export, is one of the principal problems that must be solved before the perishables industry can expand. The great distances over which perishables must be shipped have prevented the utilization of Brazil's agricultural resources, both for domestic consumption and for export. The recent development of liquid nitrogen refrigeration could provide an important alternative to mechanical and cold-plate refrigeration systems in transporting perishables.

A maintenance-free refrigeration system has great appeal to transporters. The liquid nitrogen system consists of only three parts: the liquid nitrogen container, the temperature indicator controller, and a pneumatic control valve. Properly installed, the container will provide no maintenance problems. The temperature indicator controller and the pneumatic control contain the only moving parts; if present development trends continue, these parts will soon be maintenance-free also.

The system has other advantages. For example, a liquid nitrogen refrigerator has more usable space than a mechanical refrigerator. Liquid nitrogen quickly reduces and maintains the temperature of frozen foods. Liquid nitrogen refrigeration also provides controlled-atmosphere protection in the cargo space. Respiration is inhibited, and liberation of heat and carbon dioxide are reduced when fruit and vegetables are held in a nitrogen atmosphere. Liquid nitrogen is now a commodity which can be produced by standard methods and distributed in large quantities.

Cost comparisons between liquid nitrogen, mechanical, and cold-plate systems depend on the type of product being shipped, maintenance schedules, the type of vehicle, and the climate. The cost of gasoline is about $0.25 per refrigeration-hour, while the cost of liquid nitrogen

is about $0.40 per refrigerator/hour. Low maintenance, low depreciation, few emergency road repairs, and reduced claims for spoiled products are an important advantage of this system. Compared with liquid nitrogen, an equivalent mechanical unit costs about twice as much initially. Based on a similar useful life for both mechanical and liquid nitrogen refrigerators, depreciation charges will be about twice as high for the mechanical refrigerator.

b. Air Rescue Equipment

Abstract #1:

N66-21157 Test and Evaluation Agency, Federal Aviation Agency, Atlantic City, N. J.

FEASIBILITY TEST OF SEARCH AND RESCUE RADIO BEACON Final Report

John H. Torbert and Francis W. Jefferson, Dec. 1965, 30 p.

This report contains the results of technical tests performed on a feasibility model of a dual-frequency VHF/UHF Search and Rescue Radio Beacon (SRRB). The SRRB was tested at facilities and at sea to investigate equipment performance and to evaluate two types of carrier modulation (constant and swept-tone). Results of the tests indicated that the concept of a dual-frequency SRRB is feasible for search and rescue operations, that its use would increase the number of search aircraft now available to include all operational military aircraft, and that the swept-tone modulation is most desirable for this application. Recommendations are made for adoption of the swept-tone modulation for emergency use and consideration.

Abstract #2:

N65-29756 Civil Aeromedical Research Inst., Federal Aviation Agency, Oklahoma City, Okla.

DEVELOPMENT OF A TRITIUM SELF-LUMINOUS LIFE RAFT LIGHT SOURCE

Ernest B. McFadden, J. D. Garner, and R. A. Masler (U. S. Radium Corp., Morristown, N. J.) in Space and Flight Equipment Assoc. "Proc. of 2nd Natl. Flight Safety, Survival and Personal Equipment Symp.", 1964, p. 36-51, refs.

A self-luminous life raft source designed as an aid to evacuation and life raft boarding is described and evaluated. The light source operates

continuously as a result of bombardment of a phosphor by beta particles emitted by tritium gas. It does not depend on any external source of energy for illumination, is not affected by temperature extremes, and has a duration of 12.6 years. The unit is not considered a radiation hazard. When mounted parallel to the plane of the life raft tube at a position of 45 degrees from the horizontal, the source is visible through an arc in excess of 180 degrees and is therefore visible to a survivor boarding the raft from above or from the water. The source is instantly visible upon raft inflation, is not subject to activation delays or failures, is ruggedly constructed, extremely reliable and requires no maintenance.

Abstract #3:

N63-19503 Arctic Aeromedical Lab., Aerospace Medical Div., Fort Wainwright, Alaska

EVALUATION OF POCKET PEN FLARE

Walter W. Millard, Feb. 1963, 9 p.

A pocket pen flare assembly was tested for possible use in supplementing an aircrew member's survival kit, i.e., to increase his signaling capability. The flares were cold tested in an environmental chamber at -70°F, a simulated altitude of 80,000 feet, and immersed in both fresh and salt water for periods of 1/2 hour to 15 hours. The flares were also field tested in an eight-day survival exercise held in Alaska. Results showed that only two out of 42 flares misfired. All flares taken on the eight-day survival exercise fired satisfactorily. Recommendation is made that all AAC (Alaskan Air Command) crew members carry one pen flare pistol and six flares.

Abstract #4:

A56-32516

EVOLUTION OF AIR FORCE RESCUE RADIO EQUIPMENT

Arthur L. Peters, Jr. (USAF, Systems Command Research and Technology Div., Systems Engineering Group, Wright-Patterson AFB, Ohio) in "NAECON '67: Proceedings of the Nineteenth Annual National Aerospace Electronics Conference, Dayton, Ohio," May 15-17, 1967, Technical Papers (A67-32467 17-14)

Conference sponsored by the Dayton Section, and the Aerospace and Electronic Systems Group of the Institute of Electrical and Electronics Engineers
Dayton, Ohio, Institute of Electrical and Electronics Engineers, Inc., 1967, p. 357-363

Brief survey of the evolution of rescue radio equipment, from the SCR-578 (Gibson Girl) to the AN/URC-64 multichannel survival radio transceiver and beacon. Also described are the VHF and UHF transceivers (AN/URC-4, 10 and 11), personal locator beacons (AN/URT-21, 27, 33), crash locator beacons (AN/ART-27, AN/URT-26V), airborne UHF direction finders (AN/ARA-25, 48, 50, 59), RF preamplifiers (AM-3259/ARC, AM-3969/AR), and go-no-go test equipment.

Abstract #5:

N65-29755 Civil Aeromedical Research Inst., Federal Aviation Agency, Oklahoma City, Okla.
FLOTATION CHARACTERISTICS OF AIRCRAFT PASSENGER SEAT CUSHIONS
E. B. McFadden and J. M. Simpson in "Space Flight Equipment Assoc." Proc. of 2nd Natl. Flight Safety Survival and Personal Equipment Symp., 1964, p. 24-35, refs.

Various types of open-cell polyether foam aircraft passenger seat cusions were investigated to determine their flotation characteristics. Seat cushions were pool tested under a static load of 14 pounds and later field tested by human subjects in light wave action. It was found that the static buoyancy testing did not simulate actual conditions of use and provided deceptive and erroneous information. In the static tests the cushions supported their loads from 18 to 60 hours, while in human testing under simulated conditions the cushions provided less than 8 minutes of adequate flotation. Recommendations were made for providing a simple means of attaching the cushion to the survivor's body and for using a combination of open- and closed-cell foam materials which would furnish adequate flotation with respect to quantity and duration without a sacrifice of seat cushion comfort.

Discussion:

As air travel within Brazil increases, there is greater likelihood of emergency or crash landings on scheduled and unscheduled flights. Their ability either to communicate with potential rescuers or to provide visible signals would be of paramount importance. Rescue parties may have to search huge (often uninhabited) areas on both land and in water. Operations would be improved if those requiring rescue could communicate with search parties by means of visible light or radio equipment.

C. Transportation Planning

Abstract #1:

N66-24201 Massachusetts Institute of Technology, Cambridge, Mass.
REGIONAL TRANSPORTATION TECHNOLOGY
Survey of Technology for High Speed Ground Transport, Part I, June 15, 1965, 523 p., refs.
C-85-65
PB-168648

Systems design parameters and technology required for development of high-speed ground rail transportation between Boston and Washington, D. C.

Abstract #2:

N66-83801 Rand Corporation, Santa Monica, Calif.
URBAN UNDERGROUND HIGHWAYS AND PARKING FACILITIES
G. A. Hoffman, August 1963, 57 p., refs.
RM-3680-RC

Abstract #3:

N66-15837 Technisch Documentatie En Informatie Centrum voor de Krugsmach, The Hague (Netherlands)
TRANSPORTATION TECHNOLOGY, STORAGE, LOADING AND UNLOADING
Review of Literature on Civilian Transport (Intern-Transport Literaturroverzicht)
July 1965, 30 p., refs., in Dutch (its No. 50)
CFSTI HC $2.00/MF $0.50
Abstracts are presented covering the transportation of goods, warehouse storage, loading and unloading methods, packing safety, and transportation aids.

Discussion:

As a result of the increasing use of trucks and buses and the expansion of the automobile industry, Brazilian highways have become heavily congested, especially within and between large urban centers and from producing to consuming centers. A comprehensive master plan for the city of Sao Paulo is being prepared to apply advanced regional and urban transportation technologies.

Urban underground highway technology could also be very successfully applied in the plans for the subway of Sao Paulo and Rio de Janeiro.

Engineering and financing plans for the proposed Sao Paulo subway, or "metro," are being prepared.

Plans are moving ahead on a subway for Rio de Janeiro to serve Laranjeiras, Mourisco, Gavea, Jardim Botanico, Praia Vermelha, and Leme. By 1980, the Carioca planners hope a metro line will carry two million people a day to midtown business offices.

Very recently the Brazilian Ministry of Transportation hired a Japanese group to plan the construction of a high-speed ground rail transportation link between Rio and Sao Paulo. Studies should start soon. Regional transportation technology could be applied to this problem.
In October 1965, the International Bank for Reconstruction and Development agreed to join the Brazilian Government in financing a survey of railways, highways, ports, and shipping to help the government formulate a 10-year master plan (1967/76) for the modernization and development of transportation. This survey, which will be undertaken with assistance from the World Bank, will cover the following: 1) overall transport coordination; 2) federal and Sao Paulo railways; 3) federal and state highways in the states of Minas Gerais, Parana, Santa Catarina, and Rio Grande do Sul, as well as feasibility studies for specific high-priority roads in those states; 4) the ports of Santos, Rio de Janeiro, and Recife; and 5) coastal shipping.

The Brazilian Government has engaged four foreign consulting firms to undertake the studies; namely, the U. S. firm of Coverdale and Colpitts for the transport coordination and railway studies; the French firm of Ingeroute for the highway studies in Minas Gerais; the Danish firm of Kampsax for the highway studies in Parana, Santa Catarina, and Rio Grande do Sul; and the Netherlands firm of Nedeco for the studies of the Ports of Santos, Rio de Janeiro, and Recife, and for those studies relating to coastal shipping. The studies now being undertaken are the first step in the master plan the Brazilian Government intends ultimately to develop.

The above-referenced documents on transportation studies could be applied by these consulting firms in dealing with specific transportation problems.

d. Refrigerated Air Transport

Abstract:

A67-18566

THE ROLE OF AIR-CONDITIONING AND REFRIGERATION IN THE AIR CARGO INDUSTRY

E. J. Overmyer (Boeing Co., Commercial Airplane Division, Renton, Washington

ASHRAE Journal, Vol. 9, February 1967, p. 51-58, 8 refs.

Attempt to acquaint members of the air-conditioning and refrigeration industry with some of the background and problems of the air cargo business, to stimulate a greater interest in certain of these problems, and to obtain help in reaching a solution. Airlines that lack large-capacity refrigeration facilities for preservation of perishables or that ship into areas not so equipped may wish to consider insulated containers with provisions for a plug-in refrigeration unit to be used on the ground for preconditioning or holding. Eventually, the volume of perishable air cargo may be great enough to warrant completely refrigerated cargo compartments. For the present, however, the need is for durable, lightweight, versatile containers with individually adjustable environments.

Discussion:

The technology related to refrigeration and air-conditioning in air cargo could be utilized by Brazilian airlines. Perishables could be

carried from the inaccessible interior to the large coastal cities to stimulate agriculture and provide a wider selection for the consumer. The projected increase of 15% per year in air cargo ton-miles for the next 10 years in the free world indicates that Brazil can also profit from the growing volume of air cargo business. The large aircraft of the future may permit the export of perishables to the United States and other countries, if suitably refrigerated and efficient air cargo terminals are available to shippers.

Commercial civil aviation in Brazil comes under the jurisdiction of the Civil Aeronautics Board (Diretoria de Aeronautica Civil-DAC) of the Air Ministry, which has regulatory powers and fixes tariffs for domestic services, taking into account such factors as costs per ton-mile, capacity offered, and degree of utilization. An important problem has been to relate tariff increases to inflation and the growing cruzeiro cost of the airlines' foreign debt. The DAC also formulates policy for domestic air transportation.

The principal operating airlines are the privately owned Empresa de Viacao Rio Grandense, S.A. (Varig), which also operates the state-owned Viacao Aerea Sao Paulo, S.A., and Loide Aereo Nacional, S.A.; Panair do Brasil, S.A., the Brazilian-controlled sister organization of Pan American Airways; and the Servicos Aereos Cruzeiro do Sul, Limitada.

Varig, the largest of these, was formed in 1953, and operates intercontinental flights. Its network was further expanded by the acquisition of two other Brazilian companies, Aerovias Brasil and Real Airlines. In 1965 its services were further extended with the acquisition of Panair do Brasil's routes to several cities in Europe and the Middle East. Today Varig links 140 cities and 23 countries in North and South America and in Europe, and plans to expand its services to the Middle East and Asia. At the beginning of 1965, of the 79 International Air Transportation Association (IATA) carriers, Varig ranked 22nd. Among domestic carriers (73 in all) it ranked 16th; in both categories combined it ranked 25th. Varig's performance in 1965 was as follows:

Mail (ton-miles)	2,532,000
Cargo (ton-miles)	26,478,000
Passenger miles	985,566,000

e. Airport Design

Abstract #1:

DEVELOPMENT OF A LOW-COST SECONDARY AIRPORT LIGHTING SYSTEM

N66-16043 Bergen Research Engineering Corp., Teterboro, N. J.

Final Report

R. G. Ross, September 1965, 34 p.

(Contract FA-WA 4615)

(RD-65-26)

Low capital cost of a lighting system for VFR night operations at secondary airfields can be achieved using a three-fold design approach. This approach employs pulsed incandescent lamps in place of xenon flash tubes and substitutes fluorescent lights for steady-burning incandescent sources when feasible. In addition, it sizes wind indicators to the legibility needs of typical secondary airport operations. The major components of the lighting system described in this report include runway edgelights, steady-burning approach and threshold lights, wind tee, rotating beacon, glide slope indicator, and obstruction lights. A field test of the prototype is recommended to evaluate the operational usefulness of the low-cost lighting. Also recommended is a new wind indicator design based on the minimum resolution of wind speed and direction needed for secondary airport operations.

Discussion:

In a country such as Brazil, where the development of remote areas may depend -- in part -- on the improvement or establishment of airport facilities, the need for a good airfield lighting system is apparent. The system described herein was developed for secondary airports in the United States and may be applicable to remote areas in Brazil. The cost of such a system is estimated at $5600, or about 30% less than a conventional lighting system.

Abstract #2:

N66-34122 Ohio River Div. Labs., Cincinnati

BASIS FOR RIGID PAVEMENT DESIGN FOR MILITARY AIRFIELDS

R. L. Hutchinson, May 1966, 77 p., refs. (its Misc. Paper No. 5-7)

IAD63414 CFSTI HC $3.00/MF $0.75

This paper is organized to present the various factors which influence the current design criteria, with a brief explanation of how the numerical values of each were derived.

Abstract #3:

A67-11841

CONCRETE PAVEMENT PERFORMANCE AT TEN CIVIL AIRPORTS

M. L. Crawley (Ralph H. Burke, Inc., Chicago, Ill.)

American Society of Civil Engineers, Aero-Space Transport Division, Journal, Vol. 92, Nov. 1966, p. 83-98, 9 refs.

Discussion of a series of surveys conducted for the purpose of evaluating the performance of concrete airport pavements 20 or more years old, by examining the durability of surfaces, functioning of jointing patterns, effects of subbase, adequacy of concrete pavement thickness, and maintenance practices. Airports exhibiting a variety of climatic conditions were chosen and include some of the oldest airports in the United States. The following factors have been especially considered: jointing, spalling, cracking, surface defects, drainage, and traffic. The results will be used to update existing airport pavement design criteria and to determine the suitability of existing pavement construction specifications, practices, and maintenance procedures.

Discussion:

The huge area of Brazil and the absence of conventional means of transport have led to the construction of numerous small airfields. Because many of these can only be used during the day, the movement of passengers and commodities is restricted. Further growth of air transportation will require the upgrading of airports to permit night operations. In addition, heavier aircraft and jets will require better airfield pavements as air feeder lines expand into the interior.

The Air Ministry is responsible for the planning, construction, and maintenance of airports, and for flight safety. The DAC administers the airports used for commercial aviation. The most important airport is Congonhas, in Sao Paulo City, followed by the two airports of Rio de Janeiro (Galeao, for international flights, and Santos Dumont, for domestic flights). Other important airports are those of Vira-Copos,

close to Campinas, which takes international flights bound for Sao Paulo, and those of Recife, Brasilia, Belo Horizonte, and Salvador. Other smaller but efficient airports are scattered throughout the county and make the extensive Brazilian air network the third largest in the world.

D. OBSERVATIONS ON MATCHING TECHNOLOGY WITH NEEDS

The examples of matches of aerospace technology with Brazil's various needs have indicated the following:

1) The matches selected reflect the judgment of one team of technologists. A different team having different experiences and interests might have selected other matches. Thus, the technical orientation of the technologists, their industrial experience, and their understanding of the economic development requirements of the developing country will heavily influence the selection of matches.

   The matches we selected are only a small fraction of the results of the computerized search. We believe that an enlarged effort beyond this pilot study would identify a greater number of matches -- perhaps ten times the number identified in our study.

2) A large percentage of the matches are not the direct result of work done under the space program. Rather, they represent work carried out by many different institutions, both in this country and abroad, and in both the private and public sectors of the economy of the country possessing the technology. Thus, as the content of the information system is enlarged, it can be expected that more matches would be identified. Technologies that stem directly from the space program (e.g., communications) appear to lead to the most novel matches and are more likely to have a significant effect on a country's economy.

3) The discussion of matches has been limited to introducing the salient concepts, indicating the areas of need, serving as a stimulant to an industry, providing an awareness of new developments an industry might undertake, and providing a starting point for its own development efforts. Indications of specific interest in a

potential match will have to come from actual contacts with Brazilians. Although the ADL technical team members were intimately acquainted with various aspects of the Brazilian economy and the various categories of needs, no discussions with Brazilian nationals from the various segments of the Brazilian economy were undertaken during this study. Such discussions could have provided valuable additional inputs to the selected matches.

4) With each match considered, the question has to be asked: Can it really be done? We believe that implementation of the matches is the most crucial aspect of technology transfer. The next chapter deals with different aspects of technology transfer, and in Chapter VI we discuss promising methods to accomplish the transfer of space-generated technology to developing nations.

V. THE ROLE OF TECHNOLOGY TRANSFER IN ECONOMIC DEVELOPMENT

In assessing the role of technology in the economic development of less advanced nations, we must recognize clearly that finding a match to the technological needs of Brazil such as those described in the preceding section, is not in itself enough. It is, in fact, only a beginning or a long first step. This has been demonstrated by the experience in this country with technology transfer programs carried out by the Atomic Energy Commission (AEC), NASA, Department of Commerce, and the Small Business Administration, and the technical assistance programs carried out abroad by AID and the Peace Corps.

The transfer process is not completed until the new technology or a modification of it is put into practice. Particularly is this true of advanced technology, which will rarely transfer as a direct solution to an identified problem. The barriers to be surmounted are not technical alone: completion of the transfer and its resulting economic and social development may be blocked or delayed by government policies or politics, tradition, fear of change, legal restrictions, marketing problems, and sheer inertia, as well as a lack of technical understanding and ability.

We cannot yet assert with complete confidence how technology transfer is best accomplished. However, there is a growing recognition of the conditions required for successful transfer. This section of the report will cover what is known and generally accepted about the transfer of technology from one culture to another, so that we may see more clearly the prospects of applying space technology resources to needs in Brazil.

A. CHARACTERISTICS OF THE TECHNOLOGY TRANSFER PROCESS

Our understanding of technology transfer has been changing rapidly in recent years, despite the fact that the process is as old as civilization itself. In this report we use the term to mean the carrying of specific technological know-how from one culture to another where it is seen as new, and putting it into practice there to serve a purpose which may differ from the one the technology was originally developed for. Transfer is brought about within a single culture, more or less routinely, as an instrument of business enterprise. Within this report we are concerned with intercultural

transfer through governmental action for economic development, and, in particular, with transfer situations in which the United States plays the role of disseminator of technology for purposes of foreign aid consistent with existing foreign policy.

Technology transfer differs in its requirements from data acquisition, information retrieval, and information interchange. For example, transfer requires people in the disseminating culture and in the recipient culture who both comprehend the technology and perceive its secondary application as a viable part of the recipient culture. Moreover, technology transfer requires the participation not only of economists, scientists, and engineers, but also of entrepreneurs, innovators, information specialists, and social scientists. Transfer also requires — at the very least— acquiescence by the possessor of the technology. Still more, it requires a will to accept on the part of the recipient.

Efficient technology transfer is not an accidental or haphazard occurrence. To achieve predictable transfers, intermediaries in the transferring society must be trained in the perception of new technologies, their meanings and implications, and their effects on other societies. The intermediaries' function is to make relevant technological information available in the recipients' language, in a form that they can understand, in a location where it is useful to them, and in an environment conducive to its acceptance by them. Such communication requires individuals who have studied the recipient culture's habits of thought, points of reference, philosophy, values, and experience, and who know how to establish credibility in that culture. Especially useful — where they can be found — are generalists with a technical education who:

- Understand the basic economics of business enterprise,
- Are imaginative and can readily grasp new concepts,
- Are fully informed of the recipient culture's research and manufacturing capabilities and its marketing objectives,
- Are capable of assessing the effects of changes in interdependent social behavior patterns and cultural values, and
- Are able to convey new ideas and deal effectively at many levels within the recipient culture.

B. ECONOMIC CONSIDERATIONS

Technology has played a major role in the development of the U.S. economy; one might expect it to contribute similarly in Brazil and in other developing nations. But the economic development of a nation is a complex, not always logical process, so the analogy may not apply. In the United States massive capital outlays continue to foster research and development. Most developing nations suffer from an acute shortage of capital, thus severely restricting their own expenditures for research and development. Where capital accumulation is the major problem, advanced technology can be introduced only with difficulty. For example, automation of production processes is not required by a labor-intensive economy where underemployment is endemic.

The economic aspects of technology transfer are closely associated with general industrial developments. The technological modernization (or the creation) of new industries requires a broad understanding of the economics of the developing country and the present conditions and future objectives of its government. For example, one needs to become familiar with a segment of industry, the conditions under which it developed, the techniques it now uses, and those that it can reasonably expect to acquire in the next decade. National policies affecting technical work may have been established, especially in developing countries that already have some technological dependence on developed countries. Moreover, established policies on foreign capital and foreign enterprises, fiscal and exchange policies, tax policies, and brand names and licensing agreements may affect specific technology transfer opportunities.

Transplanted technology cannot be of lasting benefit unless it takes root and enhances the processes of production and the satisfaction of human needs. The transfer will be aided by incentives to modernize and improve technology and by competition among enterprises so that overall productivity can increase. Specific enterprises can be chosen to serve as "bridges of technology" by sharing their newly acquired technical capability with others.

C. IMPLEMENTING TECHNOLOGY TRANSFER

1. Prerequisites

The method by which any society uses science to solve practical problems may be called "technology application." "Technology" may be thought of as

a systemization of an industry. For example, the technology of steel making comprises a body of knowledge and practice shared by several hundred thousand people and an output valued in billions of dollars. Within this specific technology are many inventions, a theory built up from many sciences (including the social sciences), a set of rules and practices, and a number of skills.

"Technology transfer" involves two distinct parties. One is the disseminator, who refines what is available for transfer, provides the means for the transfer, and possibly helps in implementing the technology in the new situation. When a major U. S. company builds and operates a new plant in a developing country, employing and training local labor, it is probably making a technology transfer. The distinction is in the degree to which the technological application changes the attitudes of the recipients with respect to the technology. Unless attitudes are also influenced, there is only an "application" of technology, not a "transfer".

The other party is the recipient, who refines his own needs for new technologies and implements their application. The result is a change in the attitudes and approach. Acceptance and implementation of new technologies depends on the actions of key people in a variety of significant positions in the recipient culture. These people must effect the necessary changes in the organizations, institutions, policies, procedures, and laws.

2. Characteristics of Innovation

Several characteristics of innovation have important implications for technology transfer. One is that any innovation gives rise to uncertainties about the future. Uncertainties associated with innovation spring from questions about technical feasibility (Can it be done?), novelty (Who has done it before? Who is doing it now?), and market (Who will buy the product? How large will the market be? What share of that market will it get? How long will it keep that share?). Furthermore, the product can change and its possible market can change with it. The original market may be ruled out by technical limitations, and a different market may suggest itself. Thus, long-term planning in a situation of uncertainty is severely limited. Planning takes on meaning only when the alternative courses of action are stated and the attendant risks can be known; it then becomes possible to

evaluate the alternatives and make decisions about trade-offs.

Another characteristic of innovation is the difficulty of reducing creativity to a system. Contrary to popular belief, innovation and technical development are not systematic and logical; they often depend on subjective and intuitive judgments, and on empirical experimentation, which is itself subject to false starts. Moreover, the work of technical people can be affected by concerns about competence, professionalism, status, and the authorship of ideas.

One other relevant characteristic of innovation is its interdisciplinary and multistage nature. Before a technological concept can become a reality, contributions from scientists, engineers, economists, manufacturing specialists, marketing specialists, managers and administrators, and social scientists will be required. These people represent varying concerns and have widely divergent attitudes and values. In addition to technical issues, they must consider problems of marketability, economics, quality, allocation of labor and capital, risk, social and political implications, national policy, and the like. Progress is guaranteed only if the many disciplines involved interact at every stage of the transfer.

3. Barriers to Innovation and Technology Transfer

Earlier we stated that the recipient should define his needs. It is difficult for him to do so in the terms of a new and unfamiliar technology, but it is crucial to an effective technology transfer. Clearly, it is unrealistic to expect a nation in need of new technology to be able to define its technological needs in terms of what might be available from the disseminator without some assistance. On the other hand, someone outside that nation could not define its needs; any attempt to do so would invite failure of effective transfer for two reasons: 1) individuals within the nation have a better knowledge of what is realistic and what order of priority should be assigned and 2) a strong commitment to make the many difficult changes necessary is essential to acceptance and implementation.

A second barrier, resistance to innovation and technology transfer, is a way of maintaining the status quo in the organizational institution or national society. Resistance is especially strong in developing nations where existing industries and institutions tend to be more traditional.

Traditional industry has the following characteristics:

- It is built on craft-based rather than science-based technology;
- It is fragmented, both in the sense of containing many small firms, and the sense of dividing the work into many steps, each under the control of separate organizations;
- Its focus is on production and on commitments to present methods and machines;
- Its commitments are protected by powerful social systems (family, company, locality, and industry) which large-scale technical change threatens; and
- It exhibits a lack of entrepreneurship, entrepreneurial models, or a willingness to take risks for the sake of gain.

These characteristics tend to reinforce one another. Relatively low profits — typical of traditional industries — lead to justifying low investment in new technology, so the industry retains its current profit level. Heavy commitment to present methods and equipment tends to reduce innovation to minor improvements, even for long-term plans. Fragmentation reduces the likelihood of major innovation. The diversion of entrepreneurs to other activities reinforces the industry in its traditional orientation.

Disseminators of technology may attempt to transfer technology that they believe to be useful, not realizing that it may not suit conditions in the developing country. An example is the development of the solar cooker for India (Khanna and Mathur, 1957; Telkes, 1959). The purpose of this cooker was to conserve the dung which traditionally is used as a fuel, so that the dung could be used as fertilizer to increase crop yields. Prototype cookers were shown to be useful in tests in this country and were shipped to India for field trials. These tests disclosed that the villagers work in their fields during the day and prepare their hot meals at night. In addition, the dung fuel imparted a characteristic flavor to the food. For these reasons, the solar cooker has not found application in India, although the basic technical concept is sound. This disappointment could have been avoided if, prior to development of the solar cooker, the farmers had been asked to discuss their needs, preferences, and social customs. Therefore, it is essential that the recipients be able to identify and make contact with the disseminators of technology.

One way to accomplish this is to consolidate and broaden the nation's industrial technological resources and expand and improve its technological institutions, so that both can act as intermediaries in the transfer process.

That technology does not occur in readily usable packages is yet another barrier to effective technology transfer. The solution of a specific problem often demands the integration of technology developed for other purposes, its adaptation to the situation at hand, and the invention of additional technology. Effective use of new technology may require more investment and creative ability than did the original creation of that technology.

Clearly, then, the problem of effecting a successful transfer has many dimensions: in addition to technical and economic aspects, there are psychological, social, cultural, political, geographical, legal, and historical issues. All these must be dealt with if successful transfer is to be achieved.

4. Requirements of the Recipient Culture

Any effort to generate acceptance and implementation confronts the attitudes and feelings of the people directly involved. These are based largely on individual perceptions and interpretations of events or of anticipated events, and are the result of personal experiences and values absorbed from a particular culture. Because each person's experiences are unique, individual differences in perceiving and interpreting will cover a wide range; yet, because of the pervasive influence of the culture in which the individuals live, there will also be basic similarities.

With respect to technology transfer and innovation, there are several areas of perception central to acceptance and implementation. First, the new technology must be perceived as being relevant; i.e., it must clearly meet some perceived, important needs -- needs for problem-solving, for development, and for change.

Second, the new technology must be perceived as not in serious conflict with the recipient's values. Otherwise, the choice will be to maintain the status quo. Means have to be found to harmonize perceptions about the new technology with established cultural values and beliefs, or the need for change must appear to be so pressing and important as to encourage a shift in existing values to permit a new order of priorities.

Third, those being asked to accept the new technology will not understand how implementation might be accomplished, unless mechanisms for absorption and incorporation are developed and understood from the outset.

Fourth, the new ideas must not be seen by those in power as being a threat to the existing political system; they are most likely to be accepted if they are perceived as enhancing the prestige and power of political leaders. These leaders must be committed to change; otherwise, it is unlikely that whole industries, or even particular organizations, will accept innovation.

Fifth, there must be some general perception of a "crisis" within the nation, and of a need to solve the crisis. It may grow out of the realization that foreign competition is producing better, cheaper products, or that growth of the economy has slowed, or that the balance of payments is in jeopardy. Once the threat is perceived, the society must immediately interpret it as requiring a shift toward innovation.

A state of crisis tends to put an organization under stress, which is likely to create internal conflict. This is particularly true when the organization's traditional response to the crisis is inadequate; then its resources for coping with threat come into play, and new views of the situation emerge. Thus, conflicts can induce change.

Change toward innovation demands time, not only for perception of crisis to turn into a sense of the need for innovation, but also for resolution of the conflicts and completion of the cycle from initial change to the re-establishment of stability.

Sixth, a vision of the future and a model for its implementation are required ("What would we be, if we were not what we are?"). The vision often associated with leaders in the nation must be vividly perceived and then communicated to all. For a vision to become reality there must be concrete examples of "the kind of thing we are trying to do."

Finally, it is useful to have champions of particular innovations. These men must be willing to fail, but only after trying every means of informal sales pressure and promotion to attain success. Far beyond the requirements of the job, champions of new developments identify with the new ideas as their own, and with their promotion as a cause.

5. Requirements of the Disseminating Culture

The disseminators will find that their assumptions about the appropriateness and benefits of the technology can be quite incorrect when applied to the recipient society with its different set of values, beliefs, and needs. Only within the frame of reference of the recipient can they become sensitive to potential obstacles to the acceptance and implementation of new ideas. Put another way, new ideas do not often sell themselves; they require promotion, education, and training. Making technology "available" through documents is necessary but not sufficient.

Available technology should be defined in understandable terms and arranged in such a way that the potential user can find what he wants easily. The disseminator should translate examples of available technology and adapt it to situations relevant to the recipient's needs and culture.

According to NASA's experience as discussed in Assessing Technology Transfer (Lesher and Howick, 1966):

> Significant transfer simply seldom occurs in the sense that a piece of hardware developed for military/space/nuclear use can be transplanted intact to another application. More often it occurs by imitation or analogy. Because effective transfer demands degrees of imitation, of concept displacement, of 'imagineering,' 'adaptioneering,' innovating, knowledge association, and extrapolation -- because it is a process to which many diverse disciplines can contribute -- and because it demands hard work on the part of both purveyor and receiver for its effectiveness, there are obvious barriers to its acceptance.
>
> The most important derivative of this (military/space) R&D effort is likely to be a new ability to solve problems. Not strictly technical problems, but those involving a mix of components: technical, managerial, psychological, social, political. If this is true, then we are unwise to watch for spunoff gadgets. Instead, we must develop the means and the wisdom to transfer an intangible.

The recipient should be helped to define his needs not only by passively making information available in convenient forms. Face-to-face discussions involving representatives of a variety of industries, institutions, and disciplines promote the necessary give-and-take approach.

6. The Roles of Government and Other Institutions

Technology transfer will benefit from joint initiative for successful implementation. The development of a clear understanding of needs and solutions requires a collaborative effort within the recipient culture among representatives of government, educational institutions, industry and trade associations, and industrial firms.

Beyond this, government can encourage development by:

- Collecting and publishing statistics about industrial progress (gross national product, numbers of firms by industry, imports, etc.),
- Controlling tariff and quota regulations to protect local business from certain forms of foreign competition, without the overprotection that destroys initiative,
- Employing fiscal policies that encourage economic growth,
- Subsidizing certain industries when this is in the national interest,
- Undertaking in the public interest major technical innovations requiring large capital investment (e.g., systems for national defense and applications of nuclear energy).

Government, together with industry, can encourage the mobility of labor and its adjustment to the disruption of technological change. Specifically, both could:

- Institute a policy on labor mobility with an effective job information system, support for workers moving to new positions, improved training and retraining programs;
- Provide encouragement so that firms threatened by new technology will diversify into more profitable areas of the economy; and
- Provide assistance to depressed areas by developing new industry based on new technology.

The effectiveness of such a contribution would have to be measured. This would involve 1) information about dislocations produced by technical change and 2) coordination of agencies of taxation, loans and subsidies, regional assistance, research and development, and manpower adjustment. The key to such a policy would be the effort to place the affected in a position to

support themselves. It would not offer support to specific industries but would introduce technological change throughout the economy.

Government policies may encourage or discourage innovation. Policies regarding patents, for example, may stimulate or inhibit technological innovation, depending on the protection they give. Antitrust policy may stimulate formation of new small firms based on new technology; on the other hand, it may prevent concentration essential to technological innovation in high-capital-investment industries. Tariff and quota policy may protect a domestic industry in its early development, or it may lull an established industry to sleep. Government procurement policy may offer opportunity for experiment in new technology, or it may impose restrictive specifications based on old technology.

Policies already in existence may have objectives quite different from those stimulating innovation. Such objectives -- which may originally have been concerned with public safety, costs, preventing monopolies, and the like -- may actually hamper innovation.

A government may deliberately create a climate favorable for technical innovation through a policy allowing maximum freedom for innovation. Means are needed for collecting data about relevant social and economic variables (e.g., the unemployed, rate of re-employment, corporate productivity and profitability) on a scale greater than now available. Data would then be available about the effects of government policies and programs. Furthermore, there would be means of interpreting information in terms of a theory or model of the relationship between government action and the economy. Finally, mechanisms for rationalizing policy decisions across the boundaries of all departments of government could be developed. Since nearly all departments of government can affect technological innovation in industry, and since one department may be in conflict with another, collaborative policy-making is needed throughout government.

Effective acceptance and implementation of new technology would be aided by technical centers where both disseminators and recipients can exchange information. These centers might be located in both countries.

They might have permanent research and administrative staffs to organize and present information. The centers, by involving government, industry, and education, would help eliminate specialization and professionalism.

Finally, behavioral scientists (especially those with backgrounds in applied anthropology or sociology) could assist everyone — whatever his discipline — in developing greater sensitivities to ways in which the transfer can be perceived.

D. ADVANCED TECHNOLOGY

Aerospace technology has a special nature. Much of it is highly advanced, in the sense that it is both technically sophisticated and recently developed. That poses several problems, but also carries some advantages.

Advanced technology is by definition new and still in a state of rapid change. Therefore, it is less well understood than older technology and often not completely tested. Its inventions are sometimes important simply because they work, although scientific understanding of why they work lags. Costs tend to be high because performance had to be rated ahead of economy within a given time span. And, of course, it is difficult to predict the future course of an advanced technology in a new setting.

Among positive consequences of advanced technology are the excitement and challenge offered to creative technical people, in contrast to that provided by fields where further technical change appears unlikely. For developing countries, excitement and challenge offer a means of attracting and holding first-rate scientists and engineers. Advanced technology can lead to the development of price-competitive exports for world markets, even in competition with mature, stable technologies. Because technological advance feeds on itself, participation in advanced fields is the best guarantee of producing further advances.

The very unpredictability of advanced technologies can be used as effective agents of change. The resistance a society can mobilize against change is greatest when the new is seen as replacing the old. Since radically new technology is difficult to perceive as a one-for-one replacement of something else, there is less resistance. Consider the difficulties which would be encountered if farmers using wooden plows are to be shown

the advantages of a long lasting, faster and deeper plowing metal-edged plow: such an innovation runs counter to tradition and may take as much effort to introduce as modern farm implements designed for specific crops and used cooperatively by a village community.

Finally, problems also change, even if they are not solved by human action. If a region cannot produce enough food, some people will move, others die. In any case, events occur that change the conditions of the problem, as well as the solutions. If the time scale of direct, problem-solving activity is as large as, or larger than, the time scale in which the problem changes significantly, then the chances of the solution's being relevant are small. This is not to say that attempts should not be made to identify and solve problems directly; direct solutions can be sought where unplanned change is slow or unlikely, or where future changes can be predicted with confidence. Otherwise, the economic planner and developer is really providing solutions to problems of the past. Transferring advanced technology into a society cannot often be done as a form of direct problem-solving. Its benefits are generally more indirect and more pervasive, and can lead to useful models for new ways of doing things.

Experience gained in industrial and agricultural developments has led to a better understanding of significant new elements in technology transfer. The U. S. Government has recognized that the methodology of technology transfer is worthy of study and financial support because of its potential for strengthening economic and social development both at home and abroad. In addition to supporting the more conventional measures of economic development programs such as technical assistance for developing countries, the United States is spending substantial sums in experimenting with transfers of advanced technology. Most of the experimentation has been sponsored by NASA, stimulated by a desire and mandate to make available the by-products of knowledge acquired as part of the space program. Quite apart from the value that technology transfer from the space program to the industrial sector of a developing nation may have, it is possible that emphasis on experimentation with the transfer itself— as exemplified by the techniques which are discussed in the next chapter— will provide a new and useful set of tools for economic and social development programs.

VI. MECHANISMS FOR TRANSFER OF SPACE-GENERATED TECHNOLOGY

In reviewing the problems and the methods for matching technical needs of developing countries with the sources of advanced technology, we have identified four types of approaches:

(1) Direct problem-solving.

Here, a specific solution is sought in the advanced technology information system. In this approach, the information transferred is narrowly restricted, and the possibilities for expansion are limited.

(2) General dissemination of information deemed pertinent to the needs of the developing nation.

This offers a way to reach small business, for example, with selected ideas; evaluation of the information is made by the recipient.

(3) Packaged technology concept.

A package of technology is assembled and applied to set up an operating model for demonstration purposes; it is duplicated, modified, or enlarged as nationals of the developing nation become familiar with the technology involved.

(4) Application of large systems.

The development of weather or communications satellites is an example of a global system that would benefit a developing nation.

In the discussion which follows, examples of the way in which each of these approaches could be used have been prepared; many are investigated to some degree to determine their value and practicality. Critical evaluation necessarily must await both a decision to implement this pilot study and an appropriate commitment of the groups involved.

A. DIRECT PROBLEM-SOLVING

Advanced technology could be used for the direct solution to an explicit technical problem. This solution would be a one-to-one match of need with resource and is comparatively easy to find once the problem is identified. Transfer of such potential solutions often involves little more than information transfer to where the problem exists. Nevertheless, some of the cautions concerning the social and psychological resistance to changed methods still apply, even when the solution

has proven useful for similar problems elsewhere. (See Chapter V.)

We have found that the computerized information system now in existence works quite well for problems of this type, since the latter can be stated in terms that are explicit and technical and can therefore be easily related to the index terms. Needs for improved hand tools, low-maintenance bearings, and protective coatings for surfaces are examples of this type of technology. In some cases, a need can be sought to match a given resource.

We believe that direct problem-solving is called for relatively infrequently and is usually not of great economic significance. Obviously, most problems of the space program are quite different from those of the industrial community in developing nations; consequently, the problems that space scientists have managed to solve are not the problems that Brazilian industry is likely to encounter.

The transfer of information of this type can be of economic importance in some cases, but the cost of matching and transfer (and, therefore, the methods employed to accomplish them) must be balanced against expected economic benefits. People with recognizable technical problems can be expected to look increasingly to literature and information sources for evidence of solutions to their problems. Therefore, effective means of disseminating information about advanced technology will be of assistance to direct problem-solving.

B. DISSEMINATION OF INFORMATION

Entrepreneuring in products and services is an activity worthy of encouragement and support in nations seeking to develop economically. The U.S. Government recognizes this fact and, through the Department of Commerce State Technical Services Program and the Small Business Administration, provides suitable assistance in a variety of forms to the small businessman in this country.

A number of space-generated innovations have been utilized by small business within the United States. Licensing of inventions and providing technical know-how are required techniques for stimulating industry in developing countries. NASA Tech Briefs are valuable for disseminating relevant technology for the entrepreneur with no large investments in machinery and equipment, no entrenched position in the market, and no access to a library with the required information. Other effective and economical methods to make information available, such as

the NASA information system itself, may also be relevant. An information center, organized along the lines of a Regional Dessemination Center and associated with a university, could rapidly and at low cost supply new technology in the form of Tech Briefs, technology surveys, and other documents to small firms with well defined interests. The Center could provide further interpretation of documents or consulting assistance as needed.

C. THE PACKAGE TECHNOLOGY CONCEPT

Although a significant number of matches can be uncovered by searching, as shown in Chapter IV, most of the space-generated technology in the information system is not relevant to specific Brazilian needs. Nevertheless, this technology can serve a valuable purpose by demonstrating new and exciting developments. Three salutary effects can stem from this:

1) The availability of advanced technology attracts and stimulates trained people, helping developing countries to offset the opportunities offered by more advanced nations.
2) Scientists and engineers can observe and emulate the "operating models" provided by packages of technology. (The indirect effects of new technology are frequently greater than the effect of a problem-solving activity.)
3) Applications of new techniques and devices are likely to be most useful when they are developed by those who not only have first-hand knowledge of the new technology but also are familiar with local practices and customs. Some other potential benefits from the use of packages of technology are these:
    - Creating a local demand for new products,
    - Promoting technical education,
    - Building future exports,
    - Fostering national pride in achievement,
    - Providing examples for local investment, and
    - Stimulating innovation and attracting capital.

To be of value in promoting economic development, packages of technology must be carefully selected. For example, at first the operating model may be relatively small-scale. It should be flexible enough to allow experimentation and modification, and it should be widely exposed to potential users and

adapters, as well as to scientists, engineers, and students.

The model should demonstrate new principles in action and convey as much as possible the breadth of applications already in use or contemplated elsewhere. It can sometimes be a way of testing or even creating demand. Although it should provide profit to the user, it should not be evaluated on the basis of short-term return on investment. It should be judged by the potential results of indirect effects, i.e., whether it could be copied or adapted and whether it could lead to positive actions by people.

The following are specific examples of the possible use of packages of technology as identified by documents within the NASA information system:

1. Advanced Food Processing*

Technology required to provide food for astronauts during space voyages has produced or contributed a number of useful developments in food processing; these could serve as precursors to future developments in food processing in a developing nation, rather than as direct solutions to economic problems. For instance, liquid nitrogen freezing of expensive and perishable foods will hardly provide an answer to meeting the nutritional requirements of people on a substandard diet; however, a small processing plant which uses this technology to preserve shrimp or other perishables could provide a demonstration unit for observation and experimentation by local food technologists and could find a small market in the big cities of Brazil to help underwrite the cost. The principal benefit may be in the wider application of this technology to the preparation of luxury foods for export once the large air freighters are available to transport perishables and create the marketing opportunities. This wider application may not occur unless the local food producers and processor can evaluate an operating unit for themselves and adapt its major features to meet their specific needs.

Some of the developments in food processing which would form a technology package are listed in Appendix C and could include the following:

- Liquid nitrogen freezing,
- High-protein prepared foods and food concentrates,
- Novel packaging techniques and materials,

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* See Appendix C for NASA information system generated citations.

- Novel food materials such as Chlorella (seaweed),
- Environment control techniques, including irradiation, ethylene oxide gas treatment, controlled atmosphere,
- New types of food processing equipment using corrosion-resistant materials such as pyroceram, titanium, stainless steel,
- New produce growing and harvesting techniques, and
- New nutritional concepts.

An operating demonstration plant that combines several of the most applicable novel techniques could be set up to provide revenues from the sale of the processed foods or from the use of the equipment. The basic goals should be exposure of these new techniques, equipment, and products to food technologists, market experts, and consumers throughout Brazil.

2. An Experimental Model Clinic*

Brazil's population could benefit from increased medical care to meet public health needs. The shortage of doctors, skilled technicians, and nurses could be alleviated by clinics with automated clinical and diagnostic procedures and few highly trained staff serving large numbers of people. The technology developed and applied to monitor the responses and body functions of astronauts in orbit has demonstrated the potential for remote readout to permit diagnosis without the actual patient contact normally required by doctors. The technology packages required for such a model clinic (Appendix D) could be selected from the wide range of documents containing information pertinent to public health needs.

The locations of model clinics should be selected with the support and cooperation of Brazilian doctors and hospital administrators. Several places would be suitable, such as a large city hospital, a rural clinic, a school of medicine or medical technology, or, possibly, a mobile unit.

The model clinic could be designed to meet the following broad needs:

- The unit could supply intensive care, computer diagnosis, automated analytic procedures, special surgical techniques, and a research and demonstration facility. The selected documents applicable to such a clinic could guide the design and planning of the unit, supplying or identifying equipment or equipment systems, and training of the staff. A small unit might consist of two MD's with suitable

* See Appendix D for NASA information system generated citations.

interests and backgrounds, one electronic engineer, five technicians, and four nurses.

- A complete unit could be designed to diagnose selected diseases for which drugs or other established medical procedures could be employed
- A unit could be designed to tour medical facilities and universities to demonstrate both hardware and techniques.
- A diagnostic and analytic laboratory could provide a service to physicians in rural areas, using radio or other communication links to a central hospital.

Examples of innovations which could be applied in model clinics are:

- Digital-computer enhancement of X-ray pictures for very clear long-distance transmission. This would permit accurate diagnosis by specialists in large medical centers, who could prescribe treatment of patients located in distant, isolated areas.
- Image intensification of electrocardiograms and electroencephalograms could be used in the diagnosis and treatment of patients living in remote areas. Specialists' views could be obtained regardless of distance and isolation of patients.
- Automatic microscopes with digital scanners and computer programming could be effective methods for overcoming the shortage of qualified personnel and avoiding possible errors by technicians. This is only one example of ways to apply electronic computers in diagnosis.
- The control of bacterial dissemination through the germicidal activity of ethylene oxide and reduction of bacterial contamination of surfaces could be introduced.
- Mitigation of physical fatigue with "Spartase" may be applicable to large populations living and working in unfavorable climatic areas.
- The use of lightweight titanium alloys in prosthetics could be of value to patients living in humid and hot areas.
- Control of endemic or epidemic diseases such as yellow fever or malaria could be attempted by means of aerial spraying in selected areas. The effectiveness could be checked by diagnostic units.
- Sight switches activated by movements of the eye could operate diverse types of equipment, assist diagnosis, or be utilized in the learning system to combat illiteracy.

3. An Advanced Technology Education System*

The design and implementation of an elementary education system for Brazil using packages of technology most probably would take one of two routes: a phased approach starting with simple photographic slide projectors or direct implementation of advanced technology.

A phased approach from simple to more complex systems has several advantages. Record players, overhead, slide, and low-cost motion picture projectors would be used in the initial phases. This is more practical from a marketing point of view, since simple audiovisual equipment can be sold to schools through sales channels already established. Once these devices and systems have demonstrated their usefulness, and after further Brazilian development of telecommunications, advanced-technology systems, such as educational television, could be introduced. If this first route is taken, advanced technology would have only limited usefulness, perhaps in component design for devices such as motion picture projectors. By the time educational television is introduced, several of the areas of advanced technology may have been further developed.

Direct implementation of advanced technology in education (television and, to a lesser extent, radio) may be highly desirable. Significant and rapid gains in elementary-level education -- especially in eliminating illiteracy -- can be attained by television-technology systems. Moreover, implementing this kind of technology at the outset could result in the accelerated installation of telecommunication networks necessary to support such systems. In short, the approach would be dramatic and visible not only to Brazilians but to the rest of the world.

If this second route is taken, advanced technology could find significant application. Many classrooms in Brazil have no room-darkening facilities. In such cases, the high-contrast black-and-white cathode-ray tube (the "optical diode faceplate" principle) can be used to produce viewable television images. Many parts of Brazil will not be accessible to television diffusion or microwave television for some years to come. In the meantime, slow-scan television (sequences of still pictures programmed from such material as filmstrips) could

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* See Appendix E for NASA information system generated citations.

be attractive, since voice bandwidths (e.g., telephone lines or radio diffusion) can be used. Video scan converters are located at each receiving set. (See Appendix E.)

Effective matching of Brazil's educational system needs to the appropriate advanced technologies could be helped by an information system located in Brazil; with it, Brazilian planners and technicians could search for new technological solutions whenever the need arises.

Considering both the many advanced-technology systems potentially useful for education and the multiplicity of local needs, a strong case can be made for an information system serving educational development. This system could prove especially timely, as Brazil will be installing various forms of educational television over the next several decades.

Some of the developments related to Brazilian education systems which could be included in the technology package (Appendix E) are:

- High-contrast (e.g.,"Daylight") cathode-ray tubes for television use,
- Image-storing cathode-ray tubes for television use,
- Image-storing vidicons,
- Video scan converters (especially as related to slow-scan television receivers),
- Video signal sampling systems and technologies,
- Disc memories applicable to video information handling,
- Reduced bandwidth video systems which are not slow-scan,
- Plasma displays for information display and storage,
- New facsimile transmission technology, and
- Film image miniaturization technology.

4. Management Techniques

The space program could not have been accomplished without the development of the unique administrative and management techniques employed by both NASA and industrial contractors supporting the space program. The transfer of management techniques can be a valuable resource for a developing country. These sophisticated techniques could be adapted to specific Brazilian circumstances through a university-affiliated institute, which could select and transfer those that are most applicable.

The large number of documents appropriate to management techniques (NASA, 1968) indicates the wealth of material on which such an institute could draw.

5. Other Technology Packages

Numerous other technology packages appear to have potential in meeting needs. Among these are:

- A "solar house" with thermal control coatings, solar stills, and heating and electric power from solar cells,
- Safety and survival techniques used in land and water exploration,
- An advanced-technology information system,
- A filament winding plant for irrigation pipes,
- Rural or industrial electrification projects using advanced methods of power generation and transmission, and
- Advanced agriculture and food production systems.

D. APPLICATION OF LARGE SYSTEMS ON A GLOBAL SCALE

This study has not been directly concerned with the potential of large-scale, space-oriented activities in technology transfer. However, any discussion of the application of space-generated technology to the needs of developing nations must at least recognize the benefits to be gained from the use of large-scale space systems. Their application in the weather and communications fields has already resulted in earth-orbiting satellite systems. Programs of this type, by their very nature, have a global impact: satellites now collect weather data on a worldwide basis, relay telephonic and television transmissions across oceans and continents, and help pinpoint the location of cities and entire land masses. The extraordinary success of these largely experimental programs has encouraged interest in new applications in such areas as navigation and air-sea traffic control, earth resources survey, and direct or distribution broadcasting from satellites to home or community receivers.

By virtue of their global character, these programs concern other countries. The Act of Congress establishing the National Aeronautics and Space Administration in 1958 declared that activities in space should be devoted to peaceful purposes for the benefit of all mankind and provided that NASA should carry out its aeronautical and space activities in cooperation with other nations. Accordingly, the United States welcomed direct foreign participation in space

research and exploration. U.S. boosters were used to launch nine satellites that were conceived, engineered, instrumented, and funded by cooperating foreign countries. Foreign experiments were carried aloft by U.S. satellites, and the United States engaged in cooperative programs (ranging from ground-based tracking and telemetry activities to joint sounding rocket experiments) with more than 60 different countries. On all of these projects, the United States shared in the cost and participated actively.

Brazil was among the first of the developing countries to realize the potential benefits to be gained from participating in space activities, both as a national effort and in cooperation with other countries, principally the United States. Since 1961 the Brazilian Space Commission (CNAE) has carried out a relatively ambitious space research program, with the principal objectives of 1) developing within Brazil the capability to conduct meaningful research in the physical sciences and 2) applying the capabilities created in the process to Brazil's growing needs for trained manpower and advanced technology. Brazil is also aware of the potential seen in the direct-applications areas: it has built and is operating a facility to receive, directly from U.S. weather satellites orbiting overhead, pictures of regional weather systems as indicated by cloud cover (Vermillion, 1968) and recently concluded an agreement with the United States for a joint program in earth resources sensing which will develop techniques and systems for acquiring, interpreting, and utilizing earth resources data from aircraft. International interest in these potential benefits led to the formation in 1959 of the United Nations Committee on the Peaceful Uses of Outer Space and the 1966 Space Treaty (UN, 1966). Direct participation in large systems on a global scale can help create a more receptive climate within the developing nation toward innovation and therefore makes this activity complementary to other technology transfer activities.

Another indication of the widespread interest in the application of space technology is the 1968 UN-sponsored conference (Vienna, August, 1968), which has the stated purpose of examining the "practical benefits to be derived from space research and exploration... and the extent to which the non-space powers, especially the developing countries, may enjoy these benefits."

The earth resources program reflects the widespread recognition of the potential benefits of satellites. Although there are as yet no earth resources

satellites and no firm commitment exists to carry out the required program, this application has been studied considerably. NERAC has searched the NASA information system on topics applicable to agricultural needs (NERAC, 1968); the results are given in Appendix F . The feelings of the participants in this study are well summarized in a statement by Shanks (1967), which is paraphrased below.

> The need for technology transfer is too urgent, the opportunities too great, to be deterred by consideration of mystique or outdated concepts. As the pace of change accelerates, the impulses of innovation become more swift and unpredictable, the need for knowledge is increased, and the necessity for cooperation and partnership between the various nations of the world community becomes more vital.

APPENDIX A

BRAZIL AND HER TECHNOLOGICAL NEEDS

Brazil represents half of South America in both area and population. It is the fifth largest country in the world in area and eighth largest in population (53 million). However, relative to its land and resources, Brazil's population is small. Unlike many other developing countries, Brazil has the natural and human resources for a potentially viable and largely self-sufficient economy. It also has the potential to be one of the world's leading exporters of agricultural and mineral products.

Brazil is one of the world's major producers of food crops, fibers, vegetable oils and waxes, and animal products. Although Brazil continues to be the world's largest producer and exporter of coffee, other crops, notably cotton, are expanding under the agricultural diversification program promoted by the federal government. The country's agricultural potential is matched by its wealth of forest and mineral resources: its reserves of iron ore rank among the highest in the world.

Yet, industry has been the most dynamic sector of Brazil's economy since 1947. The increased output of iron and steel after World War II accelerated industrialization to the point where manufacturing now produces 25% of the gross domestic product, almost as large a contribution to the total national income as the 30% from agricultural output. Industrial growth, however, has been accompanied by all the economic and social problems inherent in the transition from an agricultural to an industrial economy:

- Population growing faster than food supply,
- Insufficient trained manpower and technicians for rapidly expanding industry,
- A lack of capital for expansion of the mining industry, electric power, water supply, and transportation facilities,
- Insufficient exports to earn the foreign exchange necessary to pay for the large imports of equipment and material required to carry on internal development, and
- Heavily over-populated and rapidly growing urban centers with insufficient housing, health, and educational facilities to meet the need.

Although Brazil is experiencing an industrial boom, the industrial base from which the country is setting out is discouragingly small. Less than 15% of the working force is engaged in manufacturing compared with over 50% in agriculture. The average national per capita income is less than $300 per year, although the regional averages within the country vary widely. For example the state of Guanabara, in the South, has a per capita income of $1700 per year, while the average in the Northeast is estimated at $100 per year.

Since the end of the 1950's, the Brazilian government has taken a number of important steps to check the deterioration of its own economy. Its initial effort, set forth in the plan Operation Pan America in 1958, generated some multilateral concepts that led to the creation of the Alliance for Progress of Latin America. A number of comprehensive and far-reaching development programs have been set up in Brazil since that time. The most recent is the Brazilian 1968-1970 Development Plan, whose main aims are the acceleration of development and the curbing of inflation. By 1970 it hopes to achieve a rate of capital formation that would 1) bring about an annual increase in the production of goods and services of 5-6%, and 2) as a minimum, result in an annual 6% growth rate in the gross national product (GNP). The Plan seeks to strengthen the role of the private sector in the economy, and to reduce federal expenditures in the GNP so as to ease fiscal pressures. Monetary and fiscal policies are proposed in the Plan that would reduce the cost of money and increase the volume of working capital available to firms.

These objectives are to be achieved along the following guidelines:

- Increase efficiency in agricultural and industrial production,
- Improve transport and communication systems,
- Cut costs in activities under government control,
- Expand production of goods, particularly industrial products, to take advantage of economies of scale,
- Further develop basic industries such as iron ore production, iron and steel, non-ferrous metals, chemicals, and capital goods,
- Set up urgent public health, education, and housing programs,
- Provide impetus for broader participation in foreign and domestic markets, and
- Support scientific and technical research.

These guidelines for Brazil's economic growth create a great many challenges for the country and point out the technological gaps that should be filled to achieve Brazil's full potential. In the following sections we cite examples taken from a number of areas where technology needs exist. We point out the importance of specific sectors to Brazil's social or economic development, and give examples of technology needs.

1. AGRICULTURE

a. Crop and Livestock

Agriculture is one of the most essential sectors of Brazil's economy. It not only provides the nation with most of its food, but employs about 55% of the national labor force and contributes more than 80% of the foreign currency earned by the country; coffee exports are responsible for roughly half of this. Except for wheat, Brazil is now almost self-sufficient agriculturally.

Agricultural products, particularly as export items, are of great potential importance to Brazilian economic growth. This potential is reflected in the success the agricultural sector has experienced without full utilization of the country's resources. For example, arable land -- about one-third of Brazil's 3.3 million square miles, or roughly five times the size of France -- is used to only one-fifth of its capacity, while the vast and fertile interior areas generally lie fallow. In the past decade industrial development has been given top economic priority in Brazil, leaving agriculture to shift for itself. In spite of the curtailed progress, agricultural output rose 50% during this period, keeping well ahead of population growth. The country's range of climatic and soil conditions is suitable for a diversity of crops, including coffee, cocoa, cotton, corn, rice, tobacco, sugar, rubber, and endless varieties of vegetables, fruits, nuts, and timber.

Brazilian farmers, however, have difficulties in the over-populated Northeast. Failure to modernize, a lack of investment in equipment and conservation programs, declining wages, and inadequate farm-to-market transportation and storage facilities have resulted in a host of problems. Thirty percent of the total Brazilian harvests never reach market. On the average there is only one tractor for each 500 hectares of cultivated land; only one agronomist for each 2136 farmers, and one veterinarian for each 66,000 head

of livestock. Fewer than 8000 students receive college-level training in agriculture, and less than 5% of the rural population has secondary education. To meet the growing demands of its increasing population and to compete in world markets, Brazil is attempting both to open its interior to agriculture and to decrease deficiencies and capitalize on existing potential resources by improving technical and educational programs.

Technological needs have also prevented Brazil from reaching its full potential in the production of livestock. Beef is by far the largest source of meat consumed in the country. It is estimated that Brazil has nearly 93 million head of cattle, of which some seven million are slaughtered annually. But because of poor stock raising methods, the beef dresses out at only half the dressed weight of that in the United States. This fact, combined with lack of transportation and refrigeration in many areas, has increased the price of beef; as a result, the per capita consumption of meat in Brazil has stayed low, despite the general rise in living standards.

To arouse greater interest in agriculture, as well as to stimulate the influx of capital to the rural sector of the economy, the federal administration and the state governments are carrying out tasks in research, experimentation, extension of agricultural soil conservation, selection and distribution of seeds, disease prevention, propagation of pedigree animals, rational animal feeding, and improvements in sanitary and veterinary products. The following are representative of specific needs in the general agricultural sector:

- Research and instruction in crop rotation, soil conservation, irrigation, crop protection, and disease control,
- Establishment of general facilities such as agricultural research stations, water reservoirs, artificial pastures, and parks to protect animals,
- Greater availability of modern agricultural machinery, storage and transport equipment, and chemicals such as fertilizers and insecticides, and
- Improvements in pasture development, feed production, crop and livestock transportation, silo construction, fence building, and marketing of foodstuffs.

b. Food Processing

The abundance of some agricultural goods and an increase in consumer demand have stimulated the food processing industry in Brazil, which in 1961 included over 4500 plants, employed nearly 132,000 workers, and produced over one-fifth of the total value of industrial output. The industry is able to meet national demand with domestic raw materials except for wheat, which must be imported. According to recent estimates, the products of Brazil's food-processing industry are worth about $1.75 billion annually.

The food-processing industry is characterized by a great diversity in efficiency of operation and quality of products. Coffee, sugar, flour, canned and dried fruits and vegetables, and dairy products are usually processed in older, less efficient plants, whereas meat packing plants -- with slaughter-houses, freezing and byproduct-utilizing equipment -- bakeries, edible oil processing plants, breweries, and soft drink plants are typically of post-World War II origin and have adequate capital and management. A well-trained labor force, working under hygienic conditions and with such refinements as microscopic quality control and statistical sampling, is the rule rather than the exception in the latter industries.

Transportation is one of the principal problems limiting expansion of the food industry into the export field. Not only must high freight rates be paid for raw materials which have to be shipped great distances, but sporadic and unreliable schedules in remote areas increase losses in perishables and contribute to higher prices and lower profits. Improvements in roads and water transportation are needed, as well as new techniques for temperature control of perishable goods in transport and storage. Some of the other needs important to the food-processing sector include better methods of marketing and production of vitamins from agricultural waste products.

2. PUBLIC HEALTH

Brazil's public health conditions reflect the large differences in living standards, housing, sanitary facilities, and diet. Therefore, the needs also vary greatly. For instance, the death rate in the major cities is relatively lower than the average rate of between 16 and 19 per 1000 inhabitants for the entire country; the major causes of death in Brazil are childhood diseases, influenza and pneumonia, cardiovascular diseases, accidents, and malignancies.

A number of diseases present a great hazard in Brazil, despite the large progressive strides that have been made in the last half century. For instance, in spite of intensive innoculation campaigns, yellow fever continues to be endemic; leprosy, affecting 5500 people a year in Brazil, is still a relatively large problem (the country reports roughly two-thirds of all leprosy cases in South America); and, approximately 100,000 cases of malaria are still diagnosed every year in Brazil.

Other diseases that present problems in Brazil include: schistosomiasis, which affects around four million persons, mainly in the northeastern areas of the country; tuberculosis, which is still diagnosed in hundreds of thousands of cases yearly; malnutrition, which is a serious problem primarily in the northern area of Brazil; and rabies. These statistics do not reflect the entire problem, for it is extremely difficult to obtain accurate epidemiologic information in Brazil due to the remoteness of some areas where these diseases occur and the lack of communications and medical personnel.

Activities related to the supervision and coordination of public health activities are entrusted to the Ministry of Health, which is responsible for research activities, and the National Food and Drug Commission. Accidents and industrial diseases, as well as hygiene and labor insurance, are the responsibility of the Ministry of Labor and Social Welfare, which also supervises assistance rendered by welfare institutes.

The following are areas of Brazilian public health that could be helped by advanced technology:

- Information dissemination (including information on birth control, dental care, nutrition, public safety, and accident prevention),
- Medical facilities and services (including federal health services, municipal and regional health centers, first-aid stations, recreation centers for children, distribution of artificial limbs, hospital equipment and facilities, and maternity and child care clinics),
- Research in the fields of computers in medicine, and prevention of diseases (including tropical, lung, and mental diseases), and
- General health programs (including dust control, industrialization

of garbage collection and waste disposal, water and air pollution, medical care in rural areas, cheaper pharmaceutical products, mass immunization, medical education, food inspection, and vitamin requirement and food additives).

3. EXPLORATION AND UTILIZATION OF NATURAL RESOURCES

a. Mineral Resources

Brazil is very rich in natural resources, which present many economic opportunities in primary and secondary industries. Iron, manganese, phosphates, limestone, gypsum, and zirconium are particularly abundant, and there are also ample reserves of bauxite, nickel, and tungsten. However, the country's vast mineral resources remain largely untapped. For instance, Brazilian mineral production now encompasses only several dozen minerals, while that of an industrial society generally encompasses more than 300.

The under-utilization of minerals stems from a number of technical deficiencies, which, if corrected, could provide the country a great many new economic opportunities. For example, only one-third of the geology of Brazil is known in great detail, resulting in the importing of minerals which it conceivably could supply itself. Therefore, the basic need in the development of Brazil's mineral resources is a thorough exploration of its mineral deposits through geological surveys. By providing information concerning the availability of minerals now being imported and revealing opportunities for greater export, these surveys would lead to a considerable improvement in the nation's balance of payments. By using aerial surveys such as air photographs and airborne electromagnetic methods of mineral exploration, trained investigators could rapidly and economically determine the petroleum and mineral potential of Brazilian regions, make estimates of the quality, quantity, and distribution of surface and underground water, select dam sites, and plant locations of highways, pipelines, and other engineering works.

Another set of economic opportunities in the field of mineral resources on which Brazil could capitalize lies in the more effective use of mined minerals. For instance, although hard coal is not in great abundance, there is an ample supply of pyritous coal, which could be made more economic and competitive through the following additional processes:

1) Extract sulfur from the pyrite to make sulfuric acid, and use sulfur or sulfuric acid in fertilizers;
2) Utilize coal residues in thermoelectric power plants, which would bring cheap power to the coal areas and would attract industry (this and the preceding step would make the Brazilian coke much more competitive with the foreign imports); and
3) Utilize coal as a raw material in the production of ammonia (for the manufacture of ammonium sulfate, ammonium nitrate, urea, nitric acid, acrilonitrile), methanol, alcohols, ketones, organic acids, gas, gasoline, kerosene, oils, fillers for road construction, cement, mixing agent, and refractory blocks.

If certain technological needs can be satisfied, another mineral resource which presents even greater economic opportunities to Brazil is oil shale. Brazil's petroleum reserves in shale are estimated at more than two billion barrels. Shale oils contain large quantities of oleofinic hydrocarbons and more oxygen, nitrogen,and sulfur derivatives of hydrocarbons than do most petroleums. Although shale oil is not always conducive to common petroleum refining methods without modification, a number of by-products may be obtained from the retorting and refining processes. Among them are ammonia, ammonium sulfate, sulfur, tar acids, tar bases, calcium nitrate, asphaltic products, coke, fuel gas, and chemical products such as detergents. In addition, the shale ash may have value as an aggregate or mineral filler and for the manufacture of such building materials as bricks and cement. All these products offer attractive opportunities for development.

Although oil shale technology is still in an evolutionary stage, it is of great interest to Brazil at present because it would enable the country to alleviate the present shortages of crude oils and natural gas. The best prospect of a national source of oil that could make Brazil self-sufficient is now considered by the government to lie in a belt of so-called bituminous shale that runs from Sao Paulo southward through Parana, Santa Catarina, and Rio Grande do Sul states. Development of the Brazilian oil-shale deposits is very attractive economically because of their favorable location in relation to the Sao Paulo and Rio de Janeiro markets, and because of the additional applications that could be found for the oil and its by-products. For instance, cheap pipeline gas (high-methane-content natural gas), which can be made at a reasonable

cost by the hydrogasification of shale oil, is an essential requirement for the direct reduction of iron ore. Therefore, with large enough supplies of pipeline gas, Brazil would be in a much better position to capitalize on its huge reserves of iron ore, which are second largest in the world.

To capitalize on these opportunities and continue reducing the country's dependence on imported crude oil and refined products, Brazil will have to meet some of the following technological needs:

- Improvements in shale processing methods,
- Efficient recovery of shale from geological formations,
- Better commercial utilization of shale by-products,
- More advanced techniques in the design of production systems, and
- Engineering and economic analysis of the synthetic products obtained from shale.

b. Forest Products

Brazil's forest land is estimated by the Food and Agriculture Organization of the United Nations (FAO) to exceed that of any other country of the world except the U.S.S.R. It totals 1,854,000 square miles, or 56.7% of the land area of Brazil. However, only 115,900 square miles, representing 6% of all forest land, is being utilized.

The three principal forest regions are the Amazon area, the Atlantic coastal zone, and the subtropical area in the South. Hardwoods predominate in the first two regions, and Parana Pine, one of Brazil's exports, is the most important stand in the South.

In addition to lumber, a number of other forest products are economically important to Brazil. For instance, in the Amazon region the collection of rubber, non-elastic gums, Brazil nuts, and a variety of fibers, nuts, essential oils, and crude drugs is a vital part of the economy. A number of products such as mate tea, Brazil nuts, and carnauba wax are important export products. The latter extracted from both wild and cultivated palms, has been a major source of wealth for Brazil's northeast dryland or "sertao" for more than a hundred years.

If Brazil is to realize the potential of its forests, it will have to make much greater use of the tropical hardwood stands of the Amazon. These forests are characterized by an immense variety of tree families and species

with a wide range of densities and physical qualities. However, only limited exploitation has taken place so far. The population in this area is thinly spread out, and local labor is not very efficient. In addition to more efficient means for cutting the trees, new technical means of storage are greatly needed. Many problems stem from the fact that the cut timber is heavily susceptible to microorganisms which destroy the cellulose.

In many cases economic exploitation of tropical forests for pulp alone would not utilize all species, and a combination of forest product industries would therefore seem desirable. The most logical procedure would be to combine pulp and paper manufacture with sawmill and plywood plants, since the latter mainly use large logs of high-density woods; combination with fiberboard manufacture can also be contemplated. Such combinations would enable virtually all species and dimensions to be turned to industrial use (including use as fuel), and selective logging could thus be avoided. Intensive logging with mechanized equipment would become possible, while problems of regeneration and management would be simplified.

Some specific technological improvements, in addition to those mentioned above, which could strengthen Brazil's forest products industry are:

- Establishment of additional pine plantations to take the place of depleted natural stands of Paran pine, as well as additional plantings of such species as eucalyptus;
- Conversion of log residues such as slabs, edgings, sawdust, and bark into saleable products such as particleboard, pulp, and mulch;
- Use of improved skidding, hauling, loading, and road building equipment; and
- Process improvements in pulping that permit greater use of short-fibered hardwoods for paper products, such as newsprint, that are presently made primarily from long-fibered softwoods.

4. INDUSTRIALIZATION

Industrialization is a national goal of Brazil. Through industrialization, it hopes to find the one million new jobs needed each year as a result of the net annual population increase of 2.5 million people. While Brazil is primarily an agricultural country, industry has been the most dynamic sector of its economy since 1947. For example, its annual average growth rate reached 9.7%

for the period 1947-1961; in 1961 its industrial output increased 7.8% and in 1964-1965 it increased by more than 5%.

Since Brazil possesses large agricultural resources, the processing of foodstuffs has been the country's most important industry; textile manufacture has been its second largest industry. Within the last decade Brazil has developed the largest iron and steel industry in Latin America, and it presently is the world's ninth largest producer of automobiles. The country also manufactures rubber products and has a substantial oil refining industry.

Because of the country's large iron ore and hydroelectric potential, more interest is being directed toward the production of capital goods. However, having the natural resources is not itself sufficient to develop a successful industry. For example, the machine tool industry, which should be one of the most successful industries in the country, considering the large demand and the abundance of the raw materials, has not achieved the productivity increases it should have in the last decade. Although there are a few notable exceptions such as Romi S.A., the world's biggest lathe manufacturer, the industry has not kept abreast of recent technological advances. To upgrade its productivity, the machine tool industry could benefit by improving its machine design, cutting materials, and materials-handling techniques. Idle machine time could be reduced by developing standardized, modular machine tools and greater production control; new technology for forming metals, such as electrical discharge machining, electrochemical machining, and chemical milling, could also be employed.

Brazil has the resources to become a major industrial power. However, industry has technological needs which should be met to assure continued industrial growth as experienced in the past decade. Two areas which are representative of needs in nearly all of Brazil's industries are electrical power and administrative sciences.

a. Electrical Power

By international standards, Brazil consumes very little electric power, although it is estimated to have the world's largest hydroelectric potential. According to Electrobras, Brazil had a per capita consumption of about 350 kwh in 1965, compared to Norway's 10,417 kwh, the United States' 5163 kwh, France's 1837 kwh, and Uruguay's 574 kwh. However, in order to appraise Brazil's electric utility market, one should divide it into two parts: the south-central region,

extending from Minas Gerais to the north of Parana State, with a per capita consumption of 550 kwh; and the rest of the country with a per capita consumption of about 150 kwh. The south-central region embraces the industrial and agricultural centers where about 80% of the total energy supplies are consumed. This region possesses a fairly well interconnected transmission system and a highly developed electric industry for the states of Sao Paulo, Rio de Janeiro, Minas Gerais, and Guanabara. The remainder of the country varies considerably in power needs. Power is supplied to a number of sizable towns, generally in the coastal region, while in the underdeveloped interior power is produced mostly for small locations and, usually, with diesel units.

The availability of power varies significantly with the region also. In the Northeast only 30% of the demand is supplied, even under optimum conditions; the Central-West and North are almost self-sufficient; in the South and East the availability is about 90% of demand. In any of these regions, the slow expansion of facilities to meet new demands retards industrial growth. During adverse weather conditions the inadequate facilities cripple existing industries. businesses, and households. Droughts -- such as in the summer of 1963 -- can reduce electric power service in Rio de Janeiro and other urban centers of the region to only a few hours a day on a staggered time-and-area basis.

Insufficient production of electricity is one of the most critical problems economic development planners have to deal with. Although programs are underway to build new generating stations, expand those already in existence, and to construct transmission and distribution networks, the country is still far from approaching its potential. Specifically, some of the technological needs of Brazil's electric power industry are:

- More efficient long-distance transmission lines,
- Rural electrification,
- Isolated, unattended power sources such as fuel cells or solar energy converters, and
- Substations to smooth peak loads.

b. Administrative Science

Another area within Brazil's industrialization program needing improvement is the field of industrial administration. Business administration training in

in Brazilian universities began only within the last ten years, and the related field of industrial administration, which applies more rigorous and scientific techniques to management, is even newer in the university curriculum. Only recently have economists been given any prestige in the academic world in Brazil; consequently, large businesses and industry have been managed by engineers and lawyers who have not been trained in the modern management disciplines that their counterparts in more industrialized economies have. The present problems that Brazil's growing industry is encountering indicate a very strong need for the application of the more advanced administrative techniques commonly used in the developed countries. For example, the following areas in the field of management science and operations research could definitely be beneficial to Brazil:

- Production planning (including scheduling, project evaluation, quality control, inventory control, marketing, and industrial engineering),
- Data processing (including general computer technology, information retrieval, and systems analysis),
- Statistical analysis (including smoothing and economic forecasting, and mathematical model building),
- Financial analysis (including machinery replacement and capital investment policies), and
- Organizational behavior (including industrial sociology, group dynamics, and human motivation).

5. HOUSING

A steady migration from rural to urban areas has created a considerable shortage of adequate housing in Brazil. In terms of economic development, housing warrants high priority as a source of increased employment and a major stimulus to industrial expansion. The production of housing materials generally requires little in the way of foreign exchange; it is labor-intensive and utilizes local raw materials. Capital requirements for factories producing housing materials are not very great. The necessary technical and management know-how is relatively easy to find in Brazil or to develop, in contrast to the requirements of more complex industries such as steel and chemicals. Moreover,

once specialized financial institutions are established in a region, they can generate additional savings to finance consumer demand, so that the housing field is not competing for the scarce capital already available.

To meet the large demand which currently exists and is still increasing, the Brazilian building industry needs to advance the state of its technology in the following areas:

- Building materials (including new applications of plastics, plywood, hardboard and particle board, high strength steels, paints, glass, insulation, and acoustic materials; off-site preparation like ready-mix concrete; and prefinished products like aluminum and wood siding, asbestos cement);
- Building methods and organizations (including production planning techniques, cost analysis, and computerized engineering feasibility analysis and design);
- Mechanical equipment (including power and hand tools, and materials handling equipment such as hoists, conveyors, tower cranes, and powered concrete buggies); and
- Structural analysis (including thin shells, sandwich panels, and prefabricated sections).

6. EDUCATION AND TRAINING

Brazilian education is in a state of transition. Trends toward popular universal education instead of education for a small privileged group, public instead of private control of the educational system, and technical and vocational education in addition to liberal arts mark the transition.

In the past, Brazil aimed toward the creation of a cultured intellectual elite. Secondary and elementary school training was largely confined to expensive private schools that prepared students in the classical tradition for a university education, where the concentration was on medicine and law. As a result, shortages currently exist for skilled people, especially in engineering, physics, chemistry, mathematics, geology, the social sciences, and business administration. The imbalance also has produced a high illiteracy rate in Brazil which varies according to locality but averages nearly 50%. Presently, only 66% of children in the appropriate age group are enrolled in primary school. There is also a very high dropout rate (as high as 75%

per year) at all levels of instruction. In 1964, rural schools accounted for only 35% of the total elementary school enrollment, although about half of Brazil's population lives in rural areas.

To develop significant populations of well-educated people at higher levels (e.g., scientists and technicians), the elementary school system should teach the basic concepts and attitudes upon which the more advanced education will be built. First, however, Brazil must have an adequate supply of qualified teachers, which it currently lacks. For example, in the primary schools there are 34 students per teacher, whereas secondary schools average 16 students per teacher and higher education averages 5. Furthermore, the educational level of most primary school teachers is only slightly above that of their students. The primary schools also lack sufficient educational materials such as books, films, and other teaching devices, which have become an integral part of modern teaching methods.

Brazil also has a need in the field of vocational training. Although industrialization has led to improvement in the educational system, Brazil can benefit from vocational training to meet the demands of the rapid industrial expansion and advancing agricultural technology by expanding facilities and improving teaching methods.

The Brazilian government has taken a number of initial steps toward improving education with such acts as the Educational Standards and Bases Law (1962), which provides federal money for upgrading the schools and prescribes educational standards. The Federal Education Council has set several targets for 1970, including enrollment percentages for each education level, goals for teachers' programs, specifications for technical training and professional curricula, and goals for apprenticeship programs. However, to reach these targets and to continue meeting the education demands beyond 1970, Brazil will need a great deal of imaginative programming and technical support in some of the following areas:

- More and better trained primary school teachers,
- Science-oriented education,
- Teaching aids (e.g., slide projectors) and laboratory equipment,
- Training oriented to the industrial development needs of the country, and
- Use of improved techniques for literacy campaigns.

7. TELECOMMUNICATIONS

Brazil's telecommunication system, while considered moderately sophisticated, is inadequate to meet the present needs and not fully prepared to meet the rapidly increasing demand envisioned in the next decade. The system includes telephones, a national and international telegraph network, television and radio-telephone.

Prior to 1961, the telecommunications system was set up and operated by more than 500 private enterprises and municipalities with no overall plan or coordination. In August 1962, the government passed a law, "Codigo Brasileino de Telecommunicacoes", that established:

- A government organization (CONTEL) to control all telecommunication service plans, and
- A government corporation (EM BRATEL) to install and operate all main trunks of the national system.

Although this has helped to guide the planning on the national level, progress has been slow; on the local level, esisting facilities are especially poor. Brazil ranks 38th in the world in the number of telephones per capita, and the equipment could be improved.

The present interstate toll plant used high frequency radio (HFR) for the basic system, and signal propagation can be adversely affected by ionospheric conditions. However, HFR is required in Brazil for several reasons. First, there is a lack of adequate electric power between centers of population in the East to support other more reliable systems (such as microwave); second, communication to the sparsely populated northern and western sections of the country is economic only with HFR. All HFR links belong to Radional (Companhia Radio Internacional do Brasil) and DCT (Departemento dos Correios e Telegrafos), and are manually switched for the most part through the Rio de Janeiro office. Channel capacity between Rio and the state capitals ranges from one channel to San Luis to five for Recife.

In contrast to the few channels required for communication between state capitals in the northern and western sections of the country, requirements between points in the southeast sector are extremely heavy. For example, the states of Sao Paulo and Rio de Janeiro, while making up less than 5% of the land area, require over 50% of the total 1.3 million telephones now

in use in the country. The Southeast also differs from the North in that most of its toll offices use automatic equipment. However, dial call service in the Southeast is very poor. "Path busy" responses from local offices run as high as 10%, while "local line busy" can run as high as 30%; thus, the percent of calls completed is very low.

To increase the capacity and reliability of the intercity toll network, Brazil will gradually have to replace the existing HFR system with microwave. This could be done by expanding from the Rio-Sao Paulo area northward along the coast and south to Porto Alegre. With this expanded system, one wideband channel could also be devoted to educational TV, thereby allowing live broadcasting and network TV programs.

For the international telecommunications system, a satellite earth terminal is currently being installed outside Rio and will be in operation by the end of the year. This terminal will be capable of two-way telephone, teletype, and data transmission between North America, Europe, and South America and will have an equivalent capacity of 12 simultaneous telephone channels. At present, the HFR system includes 35 international circuits; the largest single requirement is New York, with 11 circuits. The other 24 circuits are allocated among 16 other nations.

Telegraph is handled in Brazil by three companies: DCT, Western Telegraph, and Radional. Traffic between all major cities along the East Coast from Belem to Porto Alegre is by undersea cable, and connections to interior points are over the DCT radio relay. Telex and international circuits are available in all principal cities of Brazil.

Television in Brazil reaches roughly 20 million people -- less than 25% of the total population. By the end of 1965 there were four million TV sets in Brazil, or five per hundred inhabitants. Although the country has approximately 60 television broadcasting stations, there is only one intercity transmission link -- between Rio and Brasilia. Very few cities have more than one station. Sao Paulo has seven TV channels, while Rio and Porto Alegre have four each. The government has reserved two UHF channels for educational TV for each of the capitals of the states and territories.

In short, the present communication system in Brazil could be improved to support the economic and population expansion currently taking place in that

country. It has been estimated that there is a present shortage of at least one million telephones and that, to meet the full demands of the country over the next decade, the total telephone system must grow at an annual rate of 10% per year.

Brazil's telecommunications industry is presently represented by six major manufacturing companies. The personnel in these companies are capable of producing the complex equipment necessary to meet the requirements of the country. With expansion of the existing facilities in these companies, the domestic needs in the telecommunication sector could be met by Brazilian enterprises. This, however, would create a need for more technically trained people to maintain and operate the expanded and improved system.

In addition to the needs mentioned above, the following are some of the areas in which the Brazilian telecommunications industry could be helped by advanced technology:

- Communications systems (including communicating with microwaves, microwave repeaters, tropospheric communications, and power supply systems),
- Satellite communications (including radio and aeronautical communication), and
- Improved communications equipment (including unattended power plants, silicon integrated circuits, multiplexing techniques, and development of switching stations).

8. TRANSPORTATION

Because of its enormous size, great distance from most of its trading partners, and wide geographical distribution of natural resources, transportation is one of the most important elements in Brazil's economic welfare. Consequently, the lack of coordinated and efficient transportation systems has been one of the biggest impediments to the development of the country's economy. High transportation costs have been largely responsible for preventing Brazilian raw materials and industrial goods from being competitive in world markets; delays caused by outdated transportation media have led to the deterioration of agricultural products before they reach the consumer; and insufficient connections between points within the interior have kept this vast country from utilizing the economies of scale of its resources. Except

for aviation, until now restricted to passenger traffic, Brazil does not have a nationwide transport network.

The high cost of transportation and the heavy reliance on trucking in Brazil have been major factors in the location of industries, especially those with a heavy transport commitment. Inadequate transportation has served as a form of protection for the less developed regions of Brazil (such as the Northeast) by encouraging local development of light industries catering essentially to regional markets, and high transportation costs (especially in the case of industries whose economic operation requires wide markets) have encouraged centralization within the Rio de Janeiro - Sao Paulo - Belo Horizonte triangle.

Brazil's present transportation networks are still strongly rooted to the country's early history. As a result of geographical factors, the Brazilian coast became densely populated and developed extensive ocean communications while the interior remained lightly populated and lacked adequate transportation. Water transport provided the principal means of moving men and goods through the Brazilian interior and along the coast between isolated beachhead communities. Roads and railways fanned out from the coastal cities to the interior with few interconnections. Most railroads and early roads in Brazil were developed to channel raw materials, such as coffee, sugar, and cocoa, from the hinterland to the nearest port. As the areas of cultivation shifted, the railway lines were kept in operation, notwithstanding their revenue losses.

a. Railroads and Highways

Brazil does not have a national rail network, but rather five different systems generally extending from the coastal regions into the interior. Although 90% of the track is standard one-meter gauge, four other gauges are in service as well. The railroad's lack of efficiency keeps it operating at a deficit, and its inadequate service affects almost all forms of commerce. A part of the railroad's problems is rooted in a freewheeling past, when governments encouraged rail construction by giving a federal bonus for each mile completed. The consequence of this incentive was that the railroad network was not laid out as efficiently as possible. For example, the road distance between Sao Paulo and Porto Alegre, capital of the state of Rio Grande do Sul, is about 1000 miles;

the distance by rail is 1600 miles. Coupled with other deficiencies, this means that cargo by rail may take as much as 15 days between the two cities compared with as little as 48 hours by road.

Even with the excess distances connecting major cities, Brazil's total railroad mileage is far below what one would expect in a country its size: although it has fifteen times the area of France, Brazil is served by roughly the same railroad mileage. Moreover, almost half the country's entire rail mileage is in the three states of Sao Paulo, Guanabra, and Minas Gerais.

Since 1960 there has been a shift away from railroads and coastal shipping to highway transport. (See Table A 1.) Although increases in highway traffic have occurred in nearly all countries, those in Brazil have been above the average. The preference for trucks over railroads and ships is the result of better service rather than freight rates, since these are higher for trucking. The over-utilization of highway transportation creates serious problems for the Brazilian economy, since it contributes to a substantial increase in the cost of production.

However, much of the apparent progress in road transport is due to the haplessness of other transport facilities rather than its own merits. Highway extension is limited and often of extremely poor quality. The 1700-mile Belem-Brasilia "highway" can take as long as two weeks to drive. Of all Brazilian roads, only about 2.5% are paved. Here again, progress has centered in the prosperous southern states.

b. Air Transportation

There are some 1200 registered airports throughout Brazil, most of which are only graded landing strips. In all, 30 airports have paved airstrips and modern ground facilities. The airports of Sao Paulo and Rio de Janeiro report the largest volume of traffic. In fact, air traffic between these two cities is second only to that between New York and Chicago. The airports at the two cities handle about 53% of all flights and transport about 40% of all passengers in the country.

Air transport has been particularly vital to Brazil because of the great distances which separate its cities and the generally poor ground connections. It has played a large part in building up the country's national unity by providing a means for more effective government control as well as more expedient

TABLE A 1

DOMESTIC INTERCITY FREIGHT TRAFFIC BY MODE OF TRANSPORT - BRAZIL, 1950-63

(billion tons/km)

Year	Highways	Railways	Maritime	Aviation	Total
1950	10.8	8.3	9.2	0.1	28.4
1955	23.1	9.3	11.3	0.1	43.8
1960	42.6	12.1	14.5	0.1	69.3
1961	47.9	12.9	15.4	0.1	76.3
1962	54.4	14.8	16.2	0.1	85.5
1963	62.1	15.3	16.4	0.1	93.9

Sources: DNER: Departamento Nacional de Estradas de Rodagen

DNEF: Departamento Nacional de Estradas de Ferro

Brazilian Embassy. Survey of the Brazilian Economy. Washington, D.C., Brazilian Embassy, 1967, 88 pp. (Documents on Brazil - 3)

freight transportation and business communication. However, the Brazilian aviation industry is currently faced with at least three major problems: low productivity of both equipment and labor, stagnation in traffic growth, and a weak financial position. These conditions may be attributed directly to inflation, since much of the old equipment is not being replaced because of the limited foreign exchange. With very sharp tariff increases in recent years, traffic over shorter distances has been diverted to other modes of transportation, reducing domestic air traffic; this, in turn, increases the load factor in some routes.

c. Waterways

The 4600-mile coastline and some 27,000 miles of navigable rivers, notably the Amazon and Parana systems, constitute valuable transportation and communication assets. Large areas of the interior still depend on water transportation, although river navigation is practically limited to the Amazon, Sao Francisco, Paraguay, and Parana. Small shallow-draft boats, in addition to pack animals and carts, constitute the principal means of local transportation in areas not penetrated by roads, railroads, navigable rivers, or areas where trucks serve only seasonally.

However, the relative importance of the waterways has declined as highways and airlines have been extended between population centers of the coast and interior. Between 1960 and 1966, coastal shipping fell nearly 50%, owing largely to inadequately maintained port facilities and strained union-management relations.

Of the 138 natural ports along the Atlantic coast, 47 are seaports and 91 are combination sea and river ports; all serve domestic and foreign vessels. The construction and maintenance of ports is a federal responsibility exercised through the Department of Ports, Rivers and Canals, or through state or private concessionaires. Government subsidies for ports have recently averaged between $15 and $20 million annually.

The steady rise in ocean freight costs has been a very important factor affecting the export-import figures in the Brazilian balance of payments. For example, Brazil bought approximately $59.4 million of U.S. goods in December 1967. The net cost was $50.7 million, but another $8.7 million went for freight and related expenses. To lessen these expenses, Brazil has embarked

on a shipbuilding program under which 24 ocean-going vessels are being constructed in domestic yards. In addition, 100,000-ton tankers bringing crude petroleum to Brazil from the Mideast will carry the ever-increasing exports of iron and other ores to Japan. These advances could be supplemented with new developments in cargo handling and transportation technology to make Brazilian exports more competitive and Brazilian imports cheaper.

The broad goals for the Brazilian transportation sector are laid out in the National Transport Plan. This plan calls for:

- A national concept of transport planning rather than a regional one, with local works left to state and municipal governments,
- The linking together of the coastal population centers,
- The connection of the capital city of Brasilia with the various state capitals,
- The ensurance of a rapid and cheap flow of industrial, mineral, and agricultural products to consumer markets and export centers,
- The development of inland waterways wherever possible, and
- The integration of the national transport net with international facilities.

Technology that could meet Brazil's needs to improve its transportation system include:

- Refrigeration and controlled-environment equipment for the transportation of perishables,
- Physical improvements of airstrips such as pavements,
- Lighting systems for night operations at secondary airfields,
- Facilities and equipment for operating airports to handle high-speed aircraft,
- Cargo handling and containerization,
- Parking facilities and synchronized traffic lights in the major metropolitan areas,
- Urban underground subways, and
- Intercity high-speed trains.

Among the documents we used to establish the technological needs of Brazil were the following:

Anon. O Brazil em Numeros, Rio de Janeiro: I.B.G.E. - Conselho Nacional de Estatistica, 1966.

Anon. Anuario Estatistico do Brasil - 1966. Rio de Janeiro: I.B.G.E. - Conselho Nacional de Estatistica, 1966.

Anon. Annual Report of Petrobras - 1966. Rio de Janeiro: Petrobras, 1967.

Anon. Electric Power in Brazil. Rio de Janeiro: Electric Power Commission, 1960, 26 pp.

Anon. Economic and Social Development of Brazil. Washington, D.C.: Organization of American States, 1962, 36 pp.

Baer, W. "Inflation and Economic Growth: An Interpretation of the Brazilian Case," Economic Development and Cultural Change, Vol. XI, No. 1, October, 1962, p. 35-97, University of Chicago Press, Chicago, Ill.

Brazilian Embassy, Survey of the Brazilian Economy, Washington, D.C., Brazilian Embassy, 1965, 254 pp. (Documents on Brazil - 2 and 4).

Brazilian Embassy, A Guide to Investing in Brazil, Washington, D.C., Brazilian Embassy, 1967, 88 pp. (Documents on Brazil - 3)

Campos, R.O., Reflections on Latin American Development, Texas, University of Texas Press, 1967, 168 pp.

Furtado, C. The Economic Development of Brasil. California: University of California Press, 1963, 285 pp.

Gordon, L.; Grommers, E.L. United States Manufacturing Investment in Brazil, Boston, The President and Fellows of Harvard College, 1962, 177 pp.

Passos, J. Brazil on the Move. Garden City, New York, Doubleday & Company, Inc., 1963, 205 pp.

Robock, S.H. Brazil's Developing Northeast: A Study of Regional Planning and Foreign Aid. Washington, D.C., The Brookings Institution, 1963, 213 pp.

Schurz, W.L. Brazil, the Infinite Country. New York, E.P. Dutton & Company, 1961, 342 pp.

United States Department of Commerce. Brazil. Washington, D.C., U.S. Government Printing Office, 1961, 214 pp.

Urquidi, V.L. The Challenge of Development in Latin America. New York, Frederick A. Praeger, 1964, 209 pp.

APPENDIX B

INTERVIEWS AND MEETINGS
To Develop Search Ideas

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Walter Olson
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Cambridge, Massachusetts

Spencer Ross (by telephone)
General Telephone & Electronics International
New York, New York

F. Gonzales, Manager of Latin American Operations
Bell & Howell Company
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C. Burns, Director of International Operations
Encyclopaedia Britannica Educational Corporation
Chicago, Illinois

Ronald Allen
A. B. Dick Company
Chicago, Illinois

William Cobbs, President
Systems for Education
Chicago, Illinois

Wilson Boothroyd, Chief Engineer (by telephone)
Sylvania Electric Products, Inc., Commercial Electronics Division
Bedford, Massachusetts

APPENDIX C

ADVANCED FOOD PROCESSING PLANT

(PACKAGE OF TECHNOLOGY)

Document Title	Abstract No.*
CRYOGENIC FREEZING	
Whole Organ Freezing and Thawing Heat Transfer and Thermal Properties	N67 22740
Principles Covering the Stability of the Ice Phase in Frozen Aqueous Substances	N62 15326
RADIATION PRESERVATION	
Radiation Technology in Conjunction with Post Harvest Procedures as Means of Extending the Shelf Life of Fruits and Vegetables	N64 12968
Preliminary Design Report. Title 1. Mobile Gamma Irradiator	N65 19821
Application of Radiochemistry Techniques in Food Processing Research Radioisotopic Tracer Techniques in Evaluation and Improvement of Industry Practices for Removal of Pesticide Residues from Foods	N65 28909
Effects of Ionizing Radiation on Lipids of Fish	N65 24236
The Canadian Program on Large Scale Production and Application of Radioisotopes	N67 15535
Radiation Technology in Conjunction with Post Harvest Procedures as a Means of Extending the Shelf Life of Fruits and Vegetables	N65 18999
SOIL PROPERTIES (Mechanical)	
Portable Soil Test Devices	N67 31929
FOOD PRODUCTION	
Biochemical Studies of Mixed Culture Prototype in a Closed Ecological System	N62 10197
Investigations of Selected Higher Plants as Gas Exchange Mechanisms for Closed Ecological Systems	N63 11475
On the Problem of Supplying the Crews of Spaceships with Animal Foodstuffs	N64 11672
Production	N67 18623

* N indicates NASA abstract
A indicates International Aerospace Abstract

Deep Submergence Materials for the Navy N65 27002

REFRIGERATION

A Food Refrigeration and Habitable Atmosphere Control System for Space Vehicles, Design, Fabrication, and Test Phases N63 16422

PACKAGING

Packaging and Preservation of Space-Vehicle Hardware N67 35007

Various Aspects of Nutrition Studied in the USSR N62 15359

PROCESSING EQUIPMENT

Corrosion Resistance of Titanium Alloys to Media in the Food Industry N67 11781

SYNTHESIZED FOODS

Keeping Astronauts Alive A66 40022

Food Quality Design for Gemini and Apollo Space Programs A67 17261

Problem of Reproduction of Food Protein by Autotrophic Organisms in Extraterrestrial Conditions A67 35228

Copolymerization of the Leuchs Anhydrides of the Eighteen Amino Acids Common to Protein A67 37397

Food in Flight A64 13449

Factors Affecting Food Development for Space Flight A64 22654

Artificial Food Products and Astronautics N64 33407

Chemical Synthesis of Protenoids Part 1. N65 18596

Potentialities of Protenoids for Nutritional Investigation N65 22180

Studies of Algae in Hungary N66 16499

Growth of Tissues in Higher Plants in Continuous Liquid Culture and Their Use in a Nutritional Experiment N65 34492

Development of Flexible Packaged Bread-Type Products Including Bread: Phase I and II -- Single and Multiple Stage Processing Methods N66 27688

Synthesis of Foodstuffs from Simple Inorganic Materials N67 20418

Plans for a Program to Study Closed Life-Support Systems N67 34586

Study of Life-Support Systems for Space Missions Exceeding One Year in Duration N67 34585

Design and Evaluation of Chemically Synthesized Food for Long Space Missions N67 34589

The Supplementary Value of Algae Protein in Human Diets A67 81325

Protein from Poisonous Primordial Soup A67 80751

Use of 50 and 100 GM of Dry Biological Bodies Containing Unicellular Algae in Food Rations of Man A67 80602

Separation of Proteins from Unicellular Algae A67 80603

Use of 150 GM of Dry Biological Bodies Containing Unicellular Algae in Food Rations of Man A67 80600

Military Creates New Foods A66 81301

FREEZE DRYING

A Study of the Microbiology of Selected Dehydrated Food Products N66 30633

DIETARY REQUIREMENTS

Effect of Four Multiples of a Basic Mixture of Essential Amino Acids on Nitrogen Retention of Adult Human Subjects A67 81170

Studies of the Maximum Capacity of Men for Physical Effort Part III. The Effects on the Maximum Oxygen Intake of Young Males of a Regime of Regular Exercise and an Adequate Diet A67 80449

Overview of United States Army Medical Service Research in Nutrition N65 18571

Nutrition and Related Studies in the Office of Space Science and Applications, NASA N65 18570

Biological Value of Plant Proteins in Relation to their Utilization in a Closed Life-Support System A67 30908

Morphological Changes in Human Scalp Hair Roots during Deprivation of Protein A67 34954

The Biochemical Bases for Developing Products of Higher Biological Value N64 23308

Superior Diet for Man in Space	N64 33044
Protein, Energy, and Water Requirements of Man under Simulated Space Stresses	N65 18601
Use of Formula Diets	N65 18599
High Energy Nonfat Nutrient Sources	N65 18598

APPENDIX D

EXPERIMENTAL MODEL CLINIC

(PACKAGE OF TECHNOLOGY)

Document Title	Abstract No.*
TELEMETRY OF VITAL SIGNS	
Recorders in Electromedical Diagnostic Apparatus	N64 2344
Construction and Use of a Simple, Self-Guiding Catheter for Right Heart and Pulmonary Artery Implantation	N64 18918
Dynamic Biotelemetry	N64 18092
Utilizing Multichannel Electronic Potentiometers for Physiological Investigations	N64 11042
The Condition and the Perspectives of Utilization of Communication, Signaling, and Telemetry in the Therapeutic Process	N64 11004
Potential for Telemetry in the Recording of Brain Waves from Animals and Men Exposed to the Stresses of Space Flight	N63 17206
A Digital Readout Technique Applicable to Laboratory and Aerospace Medical Monitoring of Physiologic Data	N63 15903
Applications of the Squegging Oscillator in Biomedical Instrumentation	N65 16621
Application of Telemetry Techniques to Hard Line Transmission of Biomedical Information on the 50-Foot Human Centrifuge	A65 24200
Instruments and Apparatus for Biological Investigation and Medical Diagnostics	N64 27927
Space Medicine: Scope, Progress and Applicability to Other Medical Fields	N64 29339
A Virtually Continuous Measurement of Human Systolic and Diastolic Blood Pressure Transients without Direct Arterial Puncture	A66 25010
Electrometry in Medicine	N65 24065
Transmission of Medical Information over Limited-Capacity Telemetry Channels	N65 13640

* N indicates NASA abstract
A indicates International Aerospace abstract

Problems of Diagnostic Information Collection in Space Flight as One of the Medical Cybernetics Trends	A65 36232
Impedance Pneumography	A65 34476
Biomedical Instrumentation in Space Medicine	A65 33281
The Flight Research Program. I -- Long-Range Program to Develop Medical Monitoring in Flight	A65 26166
Diagnostic Application of Ultrasound	N64 30238
The Application of Radio Telemetering to Space Medicine	N64 30235
Soviet Biomedical Monitoring in Space Flight -- Methods, Techniques, and Equipment -- A Collection of Abstracts	N63 23506
International Telemetering Conference, London	A64 17415
Neurophysiological Aspects of Space Flight	A63 17899
Automation and Telemetry in Cosmic Medicine	A66 82253
Biomedical Telemetry	A66 81291
Radiotelemetry: A Clinical Perspective	A66 81292
Radiotelemetry during Cardiac Exercise Tests	A66 81293
Data Redundancy Reduction for Biomedical Telemetry	A66 81294
The Developing Challenge of Biosensor and Bioinstrumentation Research	A66 81295
Collecting the Body's Signals	A67 32666
Vibrophonocardiograph Investigation and Development Study	A67 41661
The Vibrocardiogram as a Cardiovascular Monitor	A67 41660
Medical and Biological Applications of Space Telemetry	N67 14889
Determination of Cardiac Output in Man by Means of Impedance Plethysmography	A67 41563
Improving Space Flight Biotelemetry	A67 32900
High-Impedance Electrocardiogram Amplifier-Transmitter for Use with Dry Electrodes	A67 29919

Progress in Long-Term Biomedical Monitoring of Human Heart Rate through the Use of Lithium Chloride Impregnated Balsa Electrodes	A67 29918
A Linear Beat-by-Beat Cardiotachometer	A67 29920
Design and Development of a Digital Cardiotachometer	A67 29921
The Use of Seismocardiography in Space Medicine	N67 11430
A Miniaturized VHF FM/FM Telemetry System	N66 25960
Sending the Pulse by Radio	N66 39467
Long-Term Biomedical Instrumentation in the Air Force Space Program	A67 11029
A Simple Time-Division Multiplexing System for Low-Frequency Bioelectric Signals	A67 12075
Problems of Diagnostic Information Collection in Space Flight as One of the Medical Cybernetics Trends	A65 36232
Radiotelemetric Equipment for Studying Physiological Processes in a Freely Moving Person	N66 26918
Apparatus for Automatic Recording of the Arterial Blood Pressure	N66 27442
A New Versatile Miniature Multi-Channel Personal Telemetry System for Medical Research	A67 28688
A High-Performance Miniaturized Preamplifier for Biological Applications	A66 12989
Rheographic Regional Method for Evaluation of Cerebral and Ocular Circulation in Cardiac and Cerebrovascular Disease	A66 14002
Monitoring and Prediction of Nervous Functions in Space	A66 14088
Biomedical Data Collection for Space Programs	A66 14090
Development and Evaluation of an Impedance Cardiac Output System	A66 32149
Real-Time Biomedical Data Converter	A66 35703
Techniques of Physiological Monitoring. Volume I - Fundamentals	N63 10152
Telemetry of Physiological Data	A63 23493
NASA Progress in Life Sciences	N64 14866

Electronic Blood Pressure Sampler and Printer	A64 27601
Bio-Instrumentation for Space Flight	N62 14206
Medical and Biological Applications of Space Telemetry - Technology Utilization Report	N65 34001
Study of the Transferral of Space Technology to Biomedicine	N65 16932
Telemetry in Surgery and Anesthesiology	N65 34003
Diagnostic Monitoring in Office Procedure	N65 34004
Telemetry and Telestimulation in Psychophysiology	N65 34005
Telemetry Systems -- Reduction to Practice	N65 34006
Practical Problems of Using Telemetry in Intensive-Care Wards	N65 34002

AUTOMATED CLINICAL TESTING

Trends and Developments in Bionics and Bioengineering	N65 16602
Significant Achievements during Six Years of Space Bioscience Research and Applications 1958-1964	N66 13899

COMPUTERIZED DIAGNOSIS AND DATA ANALYSIS

Challenges of Modern Control Theory	N64 21161
Upper Bounds for the Mean Life of Self-Repairing Systems	N64 19399
Bibliography of Bioengineering Models and Model Matching Methods for Analog and Hybrid Computers	N64 17491
Trends in the Development and Applications of Analog Simulations in Bio-Medical Systems	N64 16691
Cybernetics in Medicine and Physiology	N64 11918
Cybernetics Approaches the Future	N64 14334
Programming the Problem of Establishing a Diagnosis for Electronic Computers	N64 11531
Cybernetics and Medicine	N64 11417
Data Processing in the Life Sciences: A Survey	N63 23420
Diagnostics and Cybernetics	N65 22729

Use of Electronic Computers for Substantiation of Diagnosis N65 22115

The Latest in Methods of Investigation of the Cardiovascular System N64 30239

Some Principles of Machine Diagnostics N65 32762

Computer Utilization of Time-Line Medical Data from Man in Space Flight N65 33350

A Machine Makes the Diagnosis N67 14385

The Selection of Diagnostic Criteria in the Construction of an Algorithm for an On-Board Computer N67 11431

Research on Advanced Computer Methods for Biological Data Processing N66 39455

On Some Principles of Machine Diagnosis N66 13032

Design of Automatic Equipment for Analyzing Ballistocardiograms N66 12222

Possibility of the Use of Electronic Logic Circuits in Automatic Medical Tests A66 29462

Analog Analysis of EEG Activity A63 12219

Electronics and Medicine N63 20744

Biomedical Monitoring In Flight N62 14203

Establishment and Operation of a Regional Research Center at MIT for Computer Technology and Research in Biomedical Sciences N64 19259

BIOMEDICAL RESEARCH AND ENGINEERING

Measurement of the Heartbeat of Bird Embryos with a Micrometeorite Transducer N64 19015

Space Medicine N63 17050

Aerospace Simulation and Human Performance Research A67 34341

The Utilization of Space Technology in the Fight against Cardiovascular Disease A67 12285

Methods for Determining Blood Flow through Intact Vessels of Experimental Animals under Conditions of Gravitational Stress and in Extraterrestrial Space·Capsules N62 11330

Problems and Research in Space Psychology N62 12786

Space Flight Problems - Mechanical, Medical, and Moral A64 26525

Space Exploration - The Practical Benefits A64 24623

Contributions and Stimulation by Aerospace Medicine to Other Branches of Medicine A64 11430

DIGITAL COMPUTER PROCESSES

Automatic Microscope. Digital Scanner and Computer Programming for Biomedical Research N64 33042

Contract to Extend the Usefulness of Cytogenetic Methodology as a Research Technique and as a Biomedical Monitoring Procedure N67 10883

Digital Computer Processing of X-Ray Photographs N67 13197

VISUAL AIDS

Technical Evaluation of a One-Inch Miniaturized Vidicon in Combination with a Miniaturized Phase Microscope N65 15367

Medical Applications of Image Intensification N62 14904

HYPERBARIC OXYGENATION

Hyperbaric Oxygenation in Medicine A67 80128

Study to Relate Apollo Space Suit Technology to the Field of Hyperbaric Medical Therapy N67 40458

LAMINAR AIRFLOW SURGICAL THEATER

The Microbial Profile of a Vertical Laminar Airflow Surgical Theater N67 34949

MEDICAL INFORMATION SYSTEM

Medical Applications of NASA-Developed Science and Technology N65 33128

A Study of the Rationale and Techniques for Long-Range Technological Forecasting in the Biological and Medical Sciences N64 24070

Computer Utilization of Time-Line Medical Data from Man in Space Flight A65 26738

Symposium on the Analysis of Central Nervous System and Cardiovascular Data Using Computer Methods N65 28750

Visually Evoked Potentials Recorded Transcranially in Man	N65 28751
On-Line Computer Techniques for Analysis of the Visual System	N65 28752
Computer Methods in the Study of Fetal Distress	N65 28753
Topological Aspects of the Organization, Processing and Presentation of Data	N65 28754
Electrographic Formats to Conform with Biophysical Research Requirements	N65 28755
Concepts of Cerebral Organization Arising from Time Series Analysis of Neurophysiological Data	N65 28756
Collection of Neurophysiological and Cardiovascular Data with Data Reduction, Pattern and Correlation Analysis	N65 28757
Hemodynamic Evaluation of Primates Before, During and After Long Periods of Weightlessness	N65 28758
Data Processing of Psychophysiological Recordings	N65 28759
Human-Aided Computer Analysis of Morphological Data	N65 28760
Automated Analysis of Heart-Rate Patterns for Biomedical Monitoring	N65 28761
System Approach to Neurophysiological Data Acquisition	N65 28762
Considerations in Use of Information Processing Technology in Clinical Investigations	N65 28763
Statistical Limits on Computer Defined EEG Patterns Related to Behavior	N65 28764
Toposcopes as Computer Interfaces	N65 28765
Definition of Parameters for Computer Analysis of Neurophysiological Data	N65 28766
Implications for Electrophysiology of a Model of Global Function Using Simple Simultaneity	N65 28767
Technical Details of Data Acquisition for the Normative Electroencephalographic Reference Library	N65 28768
Computer Analysis of the Effects of Bedrest on Cardiac Dynamics	N65 28769

Experimental Analysis of Complex Behavioral Repertoires under Continuous Environmental Control N65 28770

Biosatellite Performance Simulations N65 28771

Biosatellite Program N65 28772

The Development of Performance Tasks Producing Fatigue in Man and Other Primates N65 28773

The Relationship between Evoked Myography and Different States of Consciousness N65 28774

The Normative Electroencephalographic Data Reference Library N65 28775

Technical Details of Data Acquisition for Normative EEG Reference Library N65 28776

Computer Aided Analyses of Brain Electrical Activity N65 28777

Sources of Information on the Effects of Human Performance on Product and Systems Effectiveness N65 20726

Human Sciences in Industry. Part I: Ergonomics N65 19805

Biomedical Problem Abstracts N67 32618

Biomedical Applications of NASA Science and Technology N67 31399

Electronic Mathematical Machines and Mathematical Methods in Medicine N66 26922

PHARMACOLOGY - TOXICOLOGY

Reduction of Bacterial Dissemination. Germicidal Activity of Ethylene Oxide. Reduction of Bacterial Contamination of Surfaces N65 29171

Applications Stemming from Bioastronautics A65 14524

Methods of Sanitizing and Deodorizing Rubberized Fabric and Producing Temporary Antistatic Films on Synthetic Materials N65 18031

The Mitigation of Physical Fatigue with "Spartase" N64 14409

Biologically Active Polyvinyl Alcohol Letilan Fibers N64 16545

PROSTHETICS - OTHER AIDS

Polymers in Medicine N64 14335

Changes in the Mechanical Properties of Synthetic Vascular Prostheses N64 11316

Titanium and Titanium Alloys N65 26962

Four Fluid-Amplifier-Controlled Medical Devices N65 17559

Upper Extremity Prosthetics Research. Human Tracking. Sensory Motor Control N65 15598

Upper Extremity Prosthetics Research. Human Tracking. Sensory Motor Control. Myoelectric Control N65 24004

Upper Extremity Prosthetics Research, Human Tracking, Sensory Motor Control, and Myoelectric Control Studies N65 1829

Environment Sensing - A New Approach to the Design of an Electronic Aid for the Blind N63 16438

A Fluid Amplifier Artificial Heart Pump N63 13388

Biocurrents in the Service of Medicine N67 14384

Bioelectric Control in Medicine N67 38739

Artificial Arms with Bioelectric Control N66 26924

Manipulators and Upper Extremity Prosthetics N66 10067

Recommendations and Discussion by Participants Regarding Future Research and Development Work N66 10066

Design and Test of a Full-Scale Wearable Exoskeletal Structure N66 10056

Performance of an Adjustable Heart Substitute N62 12967

USE OF ISOTOPES AND RADIATION IN THERAPY AND DIAGNOSIS

Biological and Medical Applications of Radioactivation Analysis N66 31762

Radiotherapy N67 15545

Medical Applications of Low-Energy X-Ray and Gamma Radiation Sources N66 24221

Use of Iodine-125 for Introral X Radiography N66 24222

Portable Devices for Isotope Chest Radiography and Other Applications N66 24227

In Vivo Measurement of Bone Mineral Content by a Transmission Technique N66 24225

Body Composition Determination by Differential Absorption of Monochromatic X-Rays N66 24224

Radioisotopic Device for Measuring Bone Mineral N66 24223

Round Table Discussion (Low-Energy X-Ray Sources and Gamma Sources and Applications) N66 24220

Developments in a Portable X-Ray Fluorescence Instrument Using Radioisotope Excitation Sources N66 24216

Organ Visualization with Scintillation-Camera Techniques N66 19347

PREVENTIVE EPIDEMIOLOGY

Disease Transmission by Aircraft A65 36001

Bioinstrumentation and Telemetry for Immunochemical Analysis A63 23508

ENDORADIOSONDES AND IMPLANTABLE SENSORS

Microcircuit-Microwatt Design Techniques for New Internal Medical Sensors A66 22298

Radio Telemetering Study of the Digestive Functions N64 30237

The Development of an Implantable, Nonocclusive, Non-invasive Blood Pressure Measuring System A63 19640

Radiotelemetric Investigation of Temperature in the Human Digestive Tract N63 22660

Development of Telemetry Devices for Dental Research N63 22980

Microcircuit-Microwatt Design Techniques for New Internal Medical Sensors N66 19991

Microelectronics in Medicine N66 21535

Biological Telecommunications A66 38483

Endoradiosondes: A State-of-the-Art Survey N63 13937

What's Ahead in Biomedical Measurements? A64 17295

PHYSICAL REHABILITATION

Applications of Space Biomedical Research to Problems of Rehabilitation N65 18532

APPENDIX E

ADVANCED TECHNOLOGY EDUCATION SYSTEMS

1. BRAZILIAN PROGRAMS

Recent data acquired from AID show that the Brazilian government has begun a program for nationwide television. CONTEL, the national authority for radio and television, has reserved 103 channels for educational television. In 1966, the National Department of Education sponsored a workshop to create materials for the future educational television network. In January 1967, the President signed a law creating a Brazilian center, located in Rio de Janeiro, for studies and action-initiation in educational television. The center already has been appropriated $400,000 and Channel 3 of National TV of Brazilia.

Brazil already has the talent and facilities to reach much of her population through television. In 1964, Brazil had 53 television stations, located in 26 capital cities and in four interior cities. Sao Paulo and Rio de Janeiro each had seven stations, eight cities had two to four stations, and 17 cities had one station. In that year Brazil had about two million television sets, or about 26 per 1000 population (the United States had 350 per 1000 population). Also, at that time there were four major television set manufacturers in Brazil producing about 20,000 sets a year each. Fifteen other manufacturers together accounted for about 40,000 sets. Furthermore, 569 interior cities had commercial radio broadcasting in 1963; this could be important, since slow-scan television technology for education might well use radio diffusion facilities.

The elementary school market for television equipment is potentially large enough to interest both entrepreneurs and the political establishment. Currently, Brazil's primary school enrollment is about 20 million. Thus, a maximum market of 100 thousand TV sets (high contrast, slow scan, and other kinds) -- an average of roughly one set per school at 40 students per grade -- can be realized.

Since the rural areas represent only 35% of the primary school enrollment but account for 50% of Brazil's population, one would expect TV to be very attractive there. However, since the municipalities and the states (in addition to the federal government) are key factors in education policy decisions, educational television will probably take hold first in wealthy city-states like Porto-Alegre (Rio Grande do Sul), Sao Paulo (Sao Paulo), and Rio de Janeiro (Guanabra).

2. SLOW-SCAN TELEVISION

Slow-scan television is a method for transmitting still pictures by television. Since a series of still pictures -- for example, a sequence of slides -- collectively amount to less information than a motion picture shown over an equal period of time, it is possible to utilize a smaller capacity channel to transmit information from the source (television station) to the user (television receiver).

Commercial television channel bandwidth is about 5 MHz, while a slow-scan television bandwidth for a picture about every 10 seconds with sound can be as low as 10 kHz; thus, a channel bandwidth reduction factor of 500 can be realized. Since information transmission cost varies approximately according to the bandwidth used, slow-scan is potentially a cheaper system to operate when many and long transmission links must be used, as would be the case for a comprehensive education system for Brazil.

Furthermore, due to its significantly lower channel bandwidth requirements, slow-scan television can use transmission systems not feasible for regular television, such as telephone lines and low-power, low-frequency radio diffusion. Slow-scan television programs can be stored on conventional 1/4 inch audio tape and do not require sophisticated video tape recorders.

As far as the television viewer is concerned, there are two kinds of slow-scan television: the kind that slowly writes one picture on the screen as it progressively erases the previous one, and the kind which shows a picture uninterrupted on the screen for several seconds and then almost instantaneously flashes on a new picture. This latter system is the one we refer to in this report as best suited for presentation of

educational material. At the present state of the art, this preferred system requires a relatively costly and technically sophisticated apparatus or "black box" to translate the off-the-air slow-scan signal to the input required for a standard television set. On the other hand, one such black box can feed any number of local television sets and provide each set with a variety of programs at little incremental cost.

Presently, the per-unit user cost of this slow-scan converter is around $5000. Mass-production, such as would be required for a comprehensive Brazilian educational system, could lower the user cost to around $500. The critical and costly technology involved in the device design is the disc memory scan converter. Some, but not all, disc scan converter designs are based on aerospace technology.

It is reasonable to forecast a scan converter design which lowers the user cost of the total slow-scan receiver conversion device to $100 or less. It is less certain whether aerospace technology would be employed in the device.

In any event, $500-$1000 for a television set slow-scan converter is not an unreasonable user cost if one takes an overall system cost-effectiveness point of view and realizes that costly and involved video systems comprising television studios, microwave or coaxial cable links, and high-powered television diffusion stations can be avoided. Educational motion picture production and materials are generally more expensive (rule of thumb: $1000 per minute); furthermore, some educators believe that still pictures sequenced with sound may be as effective as motion pictures for teaching reading and many other subjects. Another important consideration is the fact that the education system can readily use, as program material, many still-picture educational materials already available in Brazil, such as film-strips, charts, and maps. These could be very expensive to copy and distribute to each schoolhouse along with audio-visual projection devices. Also, the use of such materials in the classroom would require greater teaching skill and effort — qualifications and attributes not generally in evidence in Brazil. On the other hand, classroom materials do bring color, variety, and vitality to the learning environment.

3. HIGH-CONTRAST TELEVISION

In Brazil, where educational television sets often would be placed in hard-to-darken classrooms, such as in the tropical areas of that country, it will be necessary to provide high-contrast image display in order to hold the students' attention. A recently-developed aerospace technology can fulfill this need, although another technique can do the job almost as well.

If reflected sunlight is the main source of light at a level of less than 6000 foot-lamberts, a polarizing filter placed over the television screen will produce the high contrast desired by reducing the light reflected from the television tube face. Such filters cost about $2.

If the television set is viewed in direct sunlight (ambient level of 10,000 foot-lamberts or more), or if it is viewed where patches of bright light mottle the screen (e.g., if the set were placed outside under a shade tree), a high-efficiency, high-contrast tube would be required. This tube is estimated to cost 10% more than a conventional 18 inch (diagonal) black-and-white tube, or about $2.50 higher. It will not be ready for at least a year, but there is no technical reason why it could not be produced by present Brazilian television tube manufacturers.

4. U. S. COMPANIES' VIEWS ON ADVANCED TECHNOLOGY FOR EDUCATIONAL SYSTEMS

We interviewed 14 U. S. companies to obtain their views on utilizing advanced technology in Brazil's educational system. Each company was selected because of its working knowledge about one or more of the following areas: 1) marketing of audiovisual or educational products in Brazil, 2) educational systems product development and marketing, and 3) aerospace technology utilization related to educational systems. The companies and the persons contacted are listed below.

Bell & Howell Company (Fred Gonzalez, Latin American Manager), 7100 McCormick Road, Chicago, Illinois 60645. Major manufacturer of still and motion picture classroom projectors in United States, and exporter to Brazil.

Encyclopaedia Brittanica Educational Corp. (Donald Hoffman, General Manager, International Division), 425 North Michigan Avenue, Chicago, Illinois 60611. Major producer of film materials for classroom projectors in United States, and exporter to Brazil.

Systems for Education (William Cobbs, President), 612 North Michigan Avenue, Chicago, Illinois. Venturesome innovators of new systems concepts for education for the United States and for literacy education in less-developed countries.

A. B. Dick Company (Ronald Allen, Product Planning Manager), 5700 West Touhy Avenue, Chicago, Illinois 60648. Innovators and technologists of image-transfer information systems, and developers of educational system products. Very active in Latin America.

General Telephone & Electronics International (Spencer Ross), 730 Third Avenue, New York, New York 10017. Carefully planning for large-scale introduction of such GT&E education products as "Blackboard by Wire" into less developed countries.

Sylvania Commercial Electronics Division (Wilson Boothroyd, Chief Engineer) Burlington Road, Bedford, Massachusetts. Advanced education products development, notably "Blackboard by Wire" system.

Raytheon Company (James Collier, Director of Corporate Planning), Executive Offices, Lexington, Massachusetts 02173. Actively involved in United States education market through Raytheon Education Corporation, a comprehensive product line subsidiary; Mideast experience in education and training; experienced users of the systems approach and advanced space and military technology; interested in entering Latin American education market.

Fairchild Camera and Instrument Corp. (Nat Meyers, Group Manager of Educational and Audio-visual Products and Services), 221 Fairchild Avenue, Plainview, Long Island, New York. Manufacturers of a motion picture projector of innovative design for classrooms and industrial training; manufacturing operations for the projector in Mexico to serve Latin American markets; other divisions of company are heavily involved with NASA technology.

C. Tennant, Sons & Co. (Kenneth Moritz, Managing Director of the Electronics Division), 100 Park Avenue, New York, New York. Major exporters of electronics and other products worldwide; actively interested in promoting exports of education and training systems to Brazil.

F & S International, Ltd. (Charles Feffer, Vice President and General Manager), 31 Union Square, New York, New York 10003. Major exporters of textbooks to all world markets; actively interested in exporting multimedia education systems to Brazil.

Radio Corporation of America, Broadcast and Communication Products Division (Marshall Carpenter, Chief, International Education Products and Systems Sales). Major manufacturers of multimedia and advanced technology education products; has sold advanced technology education systems in Latin America; other parts of company are major participants in NASA program.

Westinghouse Learning Corporation Division, Westinghouse Electric Corporation (Donald Laviana, Learning Aids Division Manager) Pittsburgh, Pennsylvania. Key innovators in new learning system concepts and technologies; major exponents of slow-scan television; heavily involved in NASA technology; actively studying and pursuing Latin American education markets.

Colorado Video, Inc. (Glen Southworth, President), Boulder, Colorado. Major innovators in slow-scan television technology.

Hartman Systems Co., Inc. (Bob Dealy, Senior Application Engineer), Hunting, New York 11748. Inventors and product-developers of "optical diode" high-contrast television tube (an aerospace technology).

The companies felt that slow-scan TV was the most useful advanced technology for Brazil's educational system. An advanced-technology power source (in the order of 200 watts' continuous power with few or no moving parts) was thought necessary for schools using TV equipment. Economical solar- or fuel-cell power supplies would have a potential application. Although not introduced until most of the interviews were completed, high-contrast television tube technology was of interest to most of the respondents.

Suggestions also arose on these applications: more efficient lenses and screens for film projectors, low-cost prefabricated construction materials for schools, and packaging TV equipment for air transport to remote areas.

Five of the interviewed companies subscribed, with varying degrees of enthusiasm, to slow-scan television as an educational tool. One of the five is withholding product development until slow-scan TV has been further tested as an educational system.

Another company has developed a low-cost slow-scan system suitable for Brazilian educational TV systems, but the company is presently too small to make the necessary sales effort. Its design includes technology from the Jet Propulsion Laboratory's trans-lunar probe, which was developed by yet another company. The large-production-quantity unit price of the slow-scan converter system (which does not include the basic television receiver) is estimated to be about $500. This cost can be reduced, in effect, since one converter can feed a number of sets with a selection of about 10 programs. The converter uses a disc memory element.

A major electronic system-oriented company feels that the need for slow-scan television has not yet been clearly established. If it were, the company would develop the required system and technologies. Should it decide to produce slow-scan TV, it would utilize a no-moving-parts scan converter (i.e., not a disc memory).

Two other product divisions are presently committed to slow-scan TV as an important part of their domestic and international educational product lines. (The domestic attraction is for telephone dial-access of programs stored on audio tape decks.)

Companies specializing in sales to Brazil and other world markets, as opposed to companies who emphasize R&D and product development, believe that market realities are more important than precise technology selection. International credit, politics, and attitudes of key officials often overshadow a conscientious effort to select the best technologies and systems. The systems-oriented firms preparing to supply the Brazilian market will use advanced technology only if government preference, market needs, and hardware system design all simultaneously point to the value of that technology.

5. RELEVANT SEARCH RESULTS

Electrostatic Imaging	N67-22568
Research and Development of High Resolution Television Tubes	N66-26594
Unique Scan Closed-Loop Television System	N66-26357
A Cathode-Ray Storage Tube	N66-10805
Pseudo-Random Dot Scan Television Systems	N65-35816

APPENDIX F

EARTH-RESOURCE SURVEYS

1. FUTURE APPLICATIONS

Remote sensing of the environment is one of the most exciting of advanced technologies. Examples of the possible uses of remote sensing in earth-resource surveys have been cited by H. E. Newell, Associate Administrator, NASA, at the Fifth Symposium on Remote Survey of Environment (University of Michigan, 1968):

> There is now considerable evidence that infrared photography permits early detection of diseased crops or trees. A recent example of this has been the use of Ektachrome IR photography for early determination of brown soft-scale and blackfly infestation on citrus trees in Weslaco, Texas.
>
> Another operational remote sensing application operated in the western mountain states in infrared forest fire monitoring from aircraft, performed by the Department of Agriculture. This function may be convertible to satellite application, including a volcano watch.
>
> Perhaps the most significant innovation in remote sensing in agriculture is the use of IR and visible-region imagery in several wavelengths from aircraft to determine crop species and variety, relative size and maturity of crops, and relative amounts of vegetation observed. Of particular significance is the fact that a large number of spectral bands -- up to 18 -- are being used, and that the multiplicity of channels provides a much greater degree of reliability than the use of a single band.
>
> The same principle has been applied in the passive and active microwave regions using multifrequency, dual polarization for soil analysis. Computer maps of soil and rock types have been generated. It remains to be seen whether it is feasible to generate such maps from space or whether one should restrict the capability to aircraft altitudes. This will depend on future sensor development and data handling

capability. But the progress is encouraging.

Operational programs in hydrology and geology remote sensing are still all from aircraft. Aside from the demonstrated potential of color photography it appears that it will take some time to sort out and develop other promising remote sensing techniques in these fields. During the past six years, it has been recognized that a definite effort is necessary to relate the complex spectra observed at aircraft altitude to the multitude of variables on the ground. A 'ground truth' program has been initiated, with the objective of measuring accurately the parameters of grain size, ground temperature, soil moisture, rock composition, air temperature, and other ambient conditions, then assessing the degree to which these parameters are reflected in the signal recorded from the aircraft. One can identify over 100 individual ground truth parameters. The objective is then to associate an identifiable spectral signature, or other distinctive reflective-emissive characteristic with each surface condition. This effort has been particularly active in geology and agriculture, but is also being advanced by other disciplines. There is no doubt that it is highly desired in geology and hydrology, where the significant parameters are harder to identify.

2. BRAZIL - U. S. COOPERATIVE PROGRAM

The potential importance of this technology to Brazil has been recognized, and in August 1967 a plan for cooperation between Brazilian and U. S. agencies on research of remote sensing for earth survey was announced. The objectives of this cooperative program are as follows:

- To develop techniques and systems for acquiring, interpreting, and utilizing earth-resoruce data from aircraft in order to determine the potential utility of spacecraft applications of these techniques;
- To provide additional scientific and technical experience, and to obtain research data useful in the development of earth-resource survey techniques;

- To familiarize Brazilian personnel with the acquisition, processing, reduction, and analysis of remote-sensor data;
- To identify promising applications of remotely sensed earth-resource data in Brazil; and
- To develop compatible data management systems to facilitate the exchange of data between the United States and Brazil.

All data acquired in this program will be available to both countries. Primary responsibility for the analysis of data will be with the country over whose territory data are obtained. Data of economic significance to either country will be brought immediately to the attention of both countries.

3. POTENTIAL APPLICATIONS TO AGRICULTURE

NERAC has selected the following document citations generally concerned with agriculture applications of remote sensing and measuring techniques:

Agricultural Application of Remote Sensing. The Potential from Space Platforms	N67 39649
Worldwide Use of Airphotos in Agriculture	N67 40161
Potential Uses of a Survey Satellite in Vegetation and Terrain Analysis	A67 35654

The possibilities and the use of specific sensing techniques can, in general, be subdivided into the separate classes of technique, irrespective of whether the information relates to actual practical application or speculative possibilities. The use of photographic techniques is predominantly discussed in the following papers, which include a noteworthy number of foreign references:

Forestry Applications of Remote Sensing	N67 13471
Aerial Photography Used in Mapping Vegetation and Soils	N65 29925
Interpreting Forests for the Purposes of Mapping	N65 29926
The Interpreting and Mapping of the Soil Covering the Forest Zone from the Example of Belo-Russia	N65 29927
The Use of Photosurveying Materials in the Large-scale Mapping of the Forest Steppe and Steppe Vegetation of Northern Kazakhstan	N65 29928

The Classification and Mapping of Desert Vegetation Combinations in Central Turkemenia According to the Materials of Aerial Surveying	N65 29929
The Experience of Interpreting and Mapping Foffer Land on Deserts and Semideserts from Aerial Photographs	N65 29932
Mapping the Groundwater in Soil Reclamation Research in the Semidesert Regions of the Caspian Area on the Basis of Aerial Surveying Materials	N65 29933
Practical Applications of Aerial Photographs in Forestry and Other Vegetation Studies, Series B, No. 36	N67 12842
Practical Applications of Aerial Photographs in Forestry and Other Vegetation Studies, Series B, No. 37	N67 12850
Practical Applications of Aerial Photographs in Forestry and Other Vegetation Studies, Series B, No. 38	N67 12851
On the Reliability of Photogrammetric Surveys in Forest Belt Areas.	N67 28082

A number of documents refer more generally than the above to multispectral sensing from ultraviolet to infrared. For example:

Vegetative, Soil, and Photographic Factors Affecting Tone in Agricultural Remote Multispectral Sensing	N67 13475
Investigations of Spectrum Matching Sensing in Agriculture, Volume 1	N68 13477
Agricultural and Forestry Uses of Thermal Infrared Data Obtained by Remote Sensing	A67 26000
The Usefulness of Thermal Infrared and Related Imagery in the Evaluation of Agricultural Resources: An Exploratory Study. Volumes I, II	N66 39305 N66 39715
The Use of High Altitude, Color and Spectrozonal Imagery for the Inventory of Wildland Resources, Volume II: The Range Resource	N66 39698
The Development of Spectrosignature Indicators of Root Disease on Large Forest Areas	N66 39700

Finally, a series of reports deals with the potential of the use of radar in vegetation mapping and analysis:

Vegetation Analysis with Radar Imagery	A67 10329
Vegetation Analysis with Radar Imagery	N67 13509
K-Band Radar in Vegetation Mapping	A67 34798
The Potential of Radar as a Remote Sensor in Agriculture: 1. A Study with K-Band Imagery in Western Kansas.	N67 36003

REFERENCES

International Treaty on the Activities of States in Outer Space, United Nations, 1966.

Jones, Paul E.; Curtice, Robert M.; Giuliano, Vincent E.; and Sherry, Murray E., 1968, "Application of Statistical Association Techniques of the NASA Document Collection", prepared by Arthur D. Little, Inc., Cambridge, Massachusetts, for NASA, Washington, D.C., NASA CR-1020,

Khanna, M.L., and Mathur, K.N., 1957, "Application of Solar Energy to Small Scale Industries", The Journal of Solar Energy, Science and Engineering, Vol. I, No. 1, p. 34.

Lesher, R.L., and Howick, G.J., 1966, Assessing Technology Transfer, Scientific and Technical Information Division, Office of Technology Utilization, National Aeronautics and Space Administration, Washington, D.C. NASA SP-5067.

McClelland, D.C., 1961, The Achieving Society, D. Van Nostrand Company, Inc., Princeton, N.J.

NASA, 1968, Management - A Continuing Literature Survey - With Indexes, Scientific and Technical Information Division, Office of Technology Utilization, National Aeronautics and Space Administration, Washington, D.C., NASA SP-7500.

NERAC, 1968, "Results of a Limited Review of Aerospace Technology to Determine its Relevance to the Agricultural Problems of a Developing Country", Final Report to Arthur D. Little, Inc., New England Research Application Center, School of Business Administration, University of Connecticut, Storrs, Connecticut.

Newell, H.E., 1968, "Current Program and Considerations of the Future for Earth Resources Survey", Fifth Symposium on Remote Sensing of Environment, Institute of Science and Technology, University of Michigan, Ann Arbor, Michigan.

Sawyer, J.E., 1954, "Entrepreneurship in Periods of Rapid Growth", in Entrepreneurship and Economic Growth, Mimeographed. Social Science Research Council and Harvard University Research Center in Entrepreneurial History, Cambridge, Massachusetts.

Shanks, M., 1967, The Innovators, Penguin Books, Baltimore, Maryland.

Telkes, M., 1959, "Solar Cooking Ovens", The Journal of Solar Energy, Science and Engineering, Vol. III, No. 1, p. 1.

The United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Organized by The Committee on Peaceful Uses of Outer Space.

Vermillion, C.H., 1968, Constructing Inexpensive Automatic Picture-Transmission Ground Stations, Technology Utilization Division, Office of Technology Utilization, National Aeronautics and Space Administration, Washington, D.C., NASA SP 5079.
(Among the practical space applications which have already been introduced in Latin America are: (a) the direct reception of weather satellite data and (b) communications by satellite. US weather satellites broadcast pictures of cloud cover which yield broad information of weather systems. With inexpensive equipment, the Automatic Picture Transmission receiver (APT), any country can record such pictures of weather systems covering a region of about 1,000 miles on a side.)

GLOSSARY

Association List: Computer printout using procedure developed by ADL for NASA ("Association Techniques of the NASA Document Collection", NASA CR-1020, February 1968).

Disseminator: The party in "technology transfer" who refines what is available for transfer, provides the means for the transfer, and who may help implement the technology in the new situation.

Explosive Metalworking: A method of forming sheet metal in which the sheet is pressed against a mold by the force of an explosive charge.

In-house Users: Users of information that are employed by the originating organization.

Microfiche: A rectangle of photographic film (present standard: approximately 4 by 6 inches) containing multiple microfilm images arranged in page sequence.

NASA Thesaurus: The authority for the indexing vocabulary that appears in the subject index of STAR and provides a total picture of the current indexing vocabulary including associated cross reference structure (NASA SP-7016).

Recipient: The party in "technology transfer" who refines his own needs for new technologies and implements their application.

Scientific and Technical Aerospace Reports (STAR): A comprehensive abstracting and indexing journal covering worldwide literature on the science and technology of space and aeronautics.

Subject Authority List: Listing of words occurring and frequencies of their occurrence distributed by year of publication within NASA information system.

Technology: Systemization of an industry.

Technology Application: The method by which any society uses sciences to solve practical problems.

Technology Transfer: The carrying of specific technological know-how from one culture to another where it is seen as new, and putting it into practice there to serve a purpose which may differ from the one the technology was originally developed for.

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